REPORT OF THE CHIEF OF THE BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE, 1941

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE,
Washington, D. C., September 22, 1941.

HON. CLAUDE R. WICKARD,
Secretary of Agriculture.

DEAR MR. SECRETARY: I submit herewith a report of the activities of the Bureau of Entomology and Plant Quarantine for the fiscal year ended June 30, 1941. This covers the work carried on under the direction of the late Chief of the Bureau, Dr. Lee A. Strong, who died June 2, 1941, and from that date to the end of the fiscal year by Avery S. Hoyt, Acting Chief of Bureau.

Sincerely yours,

P. N. ANNAND, *Chief.*

CONTENTS

INTRODUCTION

A new division known as the Division of Cooperative Field Relations, which was set up in the latter part of the last fiscal year, became fully operative during the present year. J. C. Holton, former Commissioner of Agriculture of Mississippi, was appointed chief of this Division and J. H. Lloyd, former Director of Agriculture of Illinois, is associated with him as assistant leader. It was decided for the time being that the headquarters of this Division would be at Memphis, Tenn.

424011—42——1

At the appropriate places in this report mention will be made of certain new activities in which the Bureau has engaged. These are occasioned by the appearance of insects new to, and not generally distributed in, the United States, or insects which have appeared in new localities and threaten valuable crops, or insects the populations of which have built up to alarming proportions. Allotments of funds were made under the general authorization for the control of incipient and emergency outbreaks of insect pests and plant diseases. The insects involved are the mole cricket in Florida, the pear psylla in the Northwest, a new scale insect, the scientific name of which is *Parlatoria chinensis*, in St. Louis, a close relative of the alfalfa weevil known as the legume weevil in parts of Arizona and California, and a scale insect attacking stone fruits and one ornamental in California known as Hall's scale.

PUBLICATIONS AND EDITORIAL WORK

At the beginning of the year 220 manuscripts were on hand, and during the year 458 were received, making a total of 678. Of these, 29 were withdrawn, 98 were published by the Department, and 313 were approved for publication in outside journals. There remained on hand at the end of the year 238 manuscripts, 172 of which were in the Bureau, 30 in the Office of Information, and 36 at the Government Printing Office. Of the 172 in the Bureau, 89 were being reviewed or edited for publication by the Department and the remaining 83 for publication outside.

The 98 publications of the Bureau issued by the Department included 8 Circulars, 11 Farmers' Bulletins, 1 Leaflet, 3 Miscellaneous Publications, 1 Picture Sheet, 6 Service and Regulatory Announcements, 10 Technical Bulletins, 4 articles in the Journal of Agricultural Research, and 54 circulars in mimeographed form.

LIBRARY

The Bureau library service is a continuing activity, and the work of the library for the year has gone forward much as during last year; no activities have been discontinued. Circulation of books and periodicals shows a slight decrease, doubtless owing to war conditions, which have reduced appreciably the material received from foreign countries.

Reference work for the various divisions of the Bureau has been constant; several very special bibliographies have been compiled, such as those on allergy in relation to insects and on the composition of raw silk. Many requests have been received from Bureau offices for reference work in connection with national defense, such as that relating to insect pests on the various islands in the Caribbean Sea and the Pacific Ocean. A special bibliography, Medical Entomology in the West Indies (Antigua, Bahamas, British Guiana, Puerto Rico, Saint Lucia, Trinidad), was prepared in response to a request coming to the Bureau from the Navy Department. To aid in establishing in South America a mailing list for Entomology Current Literature, a list of South American entomological institutions and entomologists, arranged by countries, was prepared.

Index VI to the Literature of American Economic Entomology, the compilation of which was completed last year, is not yet ready for publication. In this index, for the first time, authorities for the insect names are to be included. The work of determining these authorities and securing approval of them by the Division of Insect Identification has proved a much greater task than was anticipated. It is hoped that the index may be ready for publication this fall.

INSECT PEST SURVEY AND INFORMATION

During the year the literature on foreign insect pests that are not established or widespread in this country, and are, therefore, a constant menace to our agriculture, has been completely indexed from 1916 to the present time. During next year it is hoped that this work will be completed back to 1913. The Division is now furnishing the Division of Foreign Plant Quarantines information formerly supplied by a subdivision of that unit, the personnel of which has been transferred to other activities. During the year the Survey added to the permanent files on the distribution and abundance of foreign insects 20,800 notes and added 4,450 species not heretofore recorded. The note files on domestic insects have been augmented by 22,300 notes and 750 species heretofore unrecorded.

The index on specific plants attacked by insects has been enlarged by 30 new genera and 75 species of plants on which there are known insect pests. During the year an index to foreign plants attacked by insects was inaugurated. This will make readily available reference to the known pests of any particular crop. The Survey was called upon during the year to make detailed reports on Survey data on 58 subjects from the several divisions of the Bureau and outside agencies.

The monthly Insect Pest Survey Bulletin was augmented by supplements on the alfalfa weevil (scouting in 1940), the European corn borer (estimates of damage in 1940, status in 1940, field status of parasites at the close of the 1939 season, colonization of parasites in 1940), the hessian fly (survey at harvesttime in 1940), the Japanese beetle (summary of parasite liberations, including the year 1940), and June beetles (populations and host preferences in southern Wisconsin in 1940).

During the year 89 press releases on entomological subjects were approved for publication, and 73 radio scripts were approved, one of which was delivered by the official in charge of the Survey. Twenty-seven exhibits at various meetings and expositions, in addition to the regular exhibit material for State fairs in the hands of the Agricultural Exhibits section of the Extension Service, were shown during the year. An exhibit loaned to the Newark Museum was returned. During the time it was on display it was viewed by 90,000 people, and more than 500 high-school students made use of a questionnaire prepared to supplement this exhibit. During the year no motion pictures or film strips were completed.

Cooperative extension work in entomology was supervised by this Bureau and the Extension Service. During the year the joint subject-matter specialist made 8 field trips and assisted with the extension work in entomology in 17 States.

Three hundred and thirty-two thousand printed publications of the Bureau were distributed from this office, not including mimeographed and other miscellaneous processed material or publications sent out on regular mailing lists or from the Division of Publications of the Department.

The mailing lists maintained in this office include approximately 30,000 addresses. Requisitions for handling duplicating and photographic material numbered 2,212 covering orders for 1,094,636 copies.

Twelve numbers of the Bureau's News Letter, comprising 398 pages, were issued during the year.

Four hundred and sixty-six new subjects were added to the file of photographic prints. During the year 125 requests for photographs were received, in consequence of which 1,699 prints were distributed. Other work of the photographic unit included preparation of 11,146 photographic prints and negatives for the several divisions of the Bureau. There are now available in the file over 5,000 photographs on entomological subjects.

COOPERATIVE FIELD RELATIONS

As the name of this Division implies, its principal function is to maintain contact with the cooperating agencies. As the Bureau cooperates with every State and with the territories and possessions, as well as with adjoining countries, this presents a large field. Cooperating agencies within the States are usually the State experiment stations and extension services, the State departments of agriculture, and, in some States, the departments of conservation. Owing to the wide range of activities of the Bureau, the cooperative work necessarily occupies a similar wide range, including pest-control and regulatory fields. It is believed that an important function of this Division is the prevention of duplication of effort or the early detection of duplication if it should occur.

FRUIT INSECT INVESTIGATIONS

APPLE AND PEAR INSECTS

An important development of the year has been field confirmation of the preceding season's laboratory discovery that a very finely divided phenothiazine is much more effective in codling moth control than the so-called standard material that has been used in most of the experimental work. It appears that much of the irregularity in the results obtained in earlier experiments with phenothiazine may have been caused by unmeasured variations in particle size.

Xanthone has shown definite promise for codling moth control in the Northwest, but the results have been rather irregular in the Middle West and East. In many experiments with xanthone the apples were considerably russeted, apparently by the early-season applications, since injury of this type did not appear in plots in which the use of xanthone was not started until midseason.

The tank-mixed nicotine bentonite-soybean oil combination, developed by the Vincennes, Ind., laboratory for codling moth control, again proved superior to the best factory-processed material. At Vincennes a large-scale control experiment with tank-mixed nicotine

bentonite for the fourth consecutive year produced more clean fruit and gave equal or better control of worms than a heavy lead arsenate-oil spray program. In this area, however, financial conditions have compelled most of the growers to go back to lead arsenate, which requires less initial outlay, although it is not necessarily less expensive when final results are considered.

The light-trap experiments at Geneva, N. Y., have been discontinued in order to release additional funds for work with Comstock's mealybug. Light traps catch large numbers of moths and effect marked reductions in population, but their utilization in practical orcharding at their present stage of development would not be profitable because of the high cost of installation and maintenance.

The work with Comstock's mealybug (*Pseudococcus comstocki* (Kuw.)) is now well under way at the Charlottesville, Va., laboratory. Preliminary biological observations have indicated the occurrence of 3 complete generations of this mealybug annually on apple in Virginia, and of 2 complete generations and a partial third in West Virginia. Commercial injury to apple fruit averaged from 3.3 to as high as 81.5 percent, the Winesap being the variety most severely affected. Three species of Japanese parasites of the mealybug were widely colonized in 1940. Two of these were recovered the same season, and both appear to have survived hibernation. The most promising is a gregarious species of *Allotropa*. This species has already been recovered from 7 of the 11 orchards in which it was released during the year and in most cases has shown a rapid build-up. Experiments were undertaken in 1940 and 1941 to determine the value of liberations of large numbers of ladybird beetles of a species used successfully against other species of mealybugs by citrus growers in California. Unfortunately the experiments in Virginia against Comstock's mealybug gave negative results.

To permit a study of a newly introduced scale insect, *Parlatoria chinensis* (Marl.), at St. Louis, Mo., decision was made in May 1941 to suspend the work of the St. Joseph, Mo., laboratory. This scale insect was found in a limited area of St. Louis in 1940, the infestation centering in and around the Missouri Botanical Garden. There was an urgent need for information on the biology of the insect and for the development of insecticide materials that might be used as a basis for control. The continuation of the work at St. Joseph on the codling moth was in doubt because of the unprecedented freeze that occurred in November 1940, which killed a great many fruit trees outright, seriously weakened a great many others, and caused the failure of the current season's crop, which would have necessitated a suspension of the orchard experimentation for the 1941 season. Therefore, the field leader in charge and the equipment of the St. Joseph laboratory were transferred to St. Louis, where a study of this introduced scale insect is now under way in cooperation with several Missouri State and local agencies.

PEACH INSECTS

During the year the work on parasites of the oriental fruit moth at Moorestown, N. J., has been concerned principally with two problems, (1) the effect of early-season mass liberation of *Macrocentrus ancylivorus* Roh. on ripe-fruit infestations in peaches and (2) the

development of means of obtaining this parasite early in the year, when large numbers are much needed but are not regularly available in quantities.

For the fourth year mass liberations of oriental fruit moth parasites were made in 1940 for direct control the same season, in contrast to smaller liberations for colonization purposes. There was a considerably lower average infestation in orchards receiving parasites than in those not receiving them, which in general appeared traceable to the influence of the parasites released. However, the reduction was not so large as during the previous 2 years.

Steady progress has been made in the development of methods for the production of the parasite *Macrocentrus ancylivorus*. Particularly good results were obtained in 1940 from field breeding cages over strawberry beds, used with the first brood of the strawberry leaf roller, an alternate host of this parasite. In this experiment 45,000 *M. ancylivorus* adults were produced with a relatively small expenditure of time and materials. Further progress is being made in 1941. In order that parasites may be available in time for liberation in experiments in Delaware, where the season is earlier than at Moorestown, N. J., part of the rearing work has been carried on under cages near Cape Charles, Va.

During the summer of 1940 a number of cases of injury attributed to the use of ethylene dichloride emulsion for peach borer control were reported from peach orchards in Virginia, Pennsylvania, and other Middle Atlantic States. A careful investigation of these reports has shown that in the great majority of the orchards in which injury occurred the real cause was sudden drops in temperature in preceding winters. In most cases there was just as much injury in orchards that received no chemical treatment of any kind as there was in similar orchards nearby that were treated with ethylene dichloride. In certain cases the material was improperly applied. In a few orchards there appears to be some possibility that ethylene dichloride has been the direct cause of injury, has intensified a condition caused originally by winter injury, or has been a factor that has contributed to winter injury. A series of experiments is being carried on at Beltsville, Md., in cooperation with the Bureau of Plant Industry, to determine the soil conditions that may result in injury to peach trees by ethylene dichloride. These studies have already shown that the danger of injury by ethylene dichloride is greater in heavy than in light soils, and that damage is more likely to occur with late treatments at very low temperatures and in water-saturated soils than under opposite conditions.

In the control of the plum curculio, soil treatments with dichloroethyl ether applied during the early part of the summer, when the insect is in the ground in the larval or pupal stage, have given favorable results in laboratory and small-scale field tests.

The survey work to determine possible insect vectors of the phony peach disease has been continued, the most intensive work having been done in certain areas in Texas, Arkansas, southern Illinois, and eastern Tennessee. Collections have been made from 81 stations in 54 localities in 11 States. Effective methods of handling subterranean root-feeding insects on peach trees have been developed, permitting feeding

tests with 173 lots of subterranean sucking insects. One hundred and thirty-two tests with various sucking insects have also been made on peach twigs and foliage. No determinations regarding transmission of the phony peach disease have yet been possible, because of the long incubation period of the disease.

From the large number of species of insects collected in the course of the survey work in connection with peach mosaic, a rather long list has been prepared of those insects that appear to have some possible connection with the transmission of peach mosaic. These have been used in extensive transmission experiments at San Bernardino, Calif., and Brownwood, Tex.

Incidental to the mosaic-insect survey, sampling stations for the collection of insects that may be involved in the transmission of the "X" disease of peaches have been established for seasonal collections in Idaho, Washington, Utah, and Colorado.

GRAPE INSECTS

In small-scale field experiments carried on near Sandusky, Ohio, the use of calcium arsenate in two applications against the first brood of the grape berry moth, followed by three applications of a processed nicotine bentonite against the second brood, gave the best control. Nearly as good control resulted from the use of four applications (two against each brood) of tank-mixed nicotine bentonite. This material was less effective against the first brood than calcium arsenate or lead arsenate, but it gave very good control of the second brood. However, the tank-mixed nicotine bentonite left a heavy visible deposit of bentonite on the grape berries, and this would be objectionable on table grapes, although it might not interfere with the marketing of grapes for juices and wines. Phenothiazine gave moderately good control of second-brood damage, left no objectionable residues, and apparently had no unfavorable effect on the foliage. In large field experiments a factory-prepared nicotine bentonite containing 14 percent of nicotine, used throughout the season, gave a fair degree of control of the grape berry moth but would be rather expensive for general use. Since it appears to be more effective against the second brood than against the first brood, a "split" program of arsenicals in the early season, followed by the nicotine bentonite, may prove to be more practical.

NUT INSECTS

Progress has been made toward the development of cultural methods of controlling the hickory shuckworm on pecan. A number of years ago experiments along this line, which were carried on chiefly in the spring and very early in the summer, gave negative results. Experiments at Albany, Ga., during 1940 showed that much of the emergence of the moths and the build-up of infestation during July and August, when the greatest destruction occurs, can be prevented if during that period infested fallen nuts in the orchard are buried in the soil to a depth of 2 inches or more. The best method of accomplishing this has been found to be the use of a disk-tiller type of implement. The use of the disk-tiller implement in two pecan orchards appeared to result in a reduction of 50 to 65 percent of the infestation by the shuckworm.

Further studies have been made at Eugene, Oreg., on the biology of the filbert worm (*Melissopus latiferreanus* (Wlsm.)). Although the infestation of filberts in the Northwest by the filbert worm remains light, marked increases in worm abundance occurred at a number of points, and 20 percent more orchards reported damage than in previous years.

DRIED-FRUIT INSECTS

Experiments carried on at Fresno, Calif., with the use of oil-filled trough barriers to prevent infestation of stored raisins by the saw-toothed grain beetle were partially successful. These experiments were designed to take advantage of the fact, observed by the Fresno laboratory, that this insect seldom flies and that most of the beetles must crawl to reach stacks of raisins in boxes. The first part of April the sampling showed 30 insects per ton in the protected stack and 9,498 per ton in the unprotected stack. Each stack contained about 4 tons of raisins. Early in May there were 2,952 insects per ton in the protected stack and 41,359 per ton in the unprotected stack. In June, however, the protected stack contained 40,340 and the unprotected raisins 60,399 per ton. It is hoped that by the use of a different type of barrier more nearly complete protection can be obtained.

Several possible methods of fumigating dried fruit in small units on the ranch at the end of the sun-drying period have been tried near Fresno, Calif. Methyl bromide, paradichlorobenzene, and dichloroethyl ether have been used for this purpose with very promising results. Some applications have been made to the fruit in rolled paper trays and others in bags or sweat boxes.

SUBTROPICAL FRUIT INSECTS

The work on the citrus rust mite in Florida has dealt chiefly with possible improvements on present practices. Confirming earlier results, the more finely divided sulfurs, such as 2,000-mesh dust or 4,000-mesh wettable sulfur, were definitely more effective and gave longer periods of protection than the ordinary 325-mesh material. This advantage, however, was largely offset by the higher cost of the finer materials. Experiments have been begun to determine the influence of cover crops on rust mite populations.

Improvement in the results of cyanide fumigation against the California red scale seems likely to result from the use of a blower to circulate the gas. Past work at the Whittier laboratory and by other organizations has indicated that an immediate high concentration of gas and a uniform declining slope of the curve, with a reasonable concentration of gas at the end of the exposure, is necessary for a satisfactory kill, but this type of concentration curve is not attained in many commercial exposures. More recent tests carried on by the Division of Insecticide Investigations have indicated that after the gas was introduced in ordinary fumigation there were at different points many pockets of low gas concentration which persisted throughout a 20-minute exposure. In a series of tests carried on under a commercial canvas tent over a form built over an orange tree, it was found that a prompt distribution of gas could be attained by the operation of a blower for 30 seconds and a uniform diminishing curve established. Preliminary tests to determine the

value of the blower were carried on under the form tent on two nights during January 1941. Without the blower the mortality ranged with the location from 56.8 to 99.7 percent; with it the mortality ranged only from 87.2 to 94.2 percent, indicating a more nearly uniform distribution of the gas and a more uniform kill as a result of the use of the blower.

Further work has been done with cube resins in oil for the control of the California red scale. Dosage-mortality tests conducted in 1940 indicated that an increasing proportion of the total spray mixture deposited on the wood became insecticidally active as the deposits increased. These tests also confirmed the results of previous tests and indicated that proportionately higher immediate kills were obtained when resins were added to light medium oil than when added to heavier oils.

With the citrus thrips, experiments have been carried on in California with sprays or dusts containing tartar emetic as their active ingredient. Experiments with compounds related to tartar emetic-potassium antimony citrate and barium antimonyl tartrate showed promise for thrips control. The last-named material is less soluble than tartar emetic and might retain its effectiveness better than the tartar emetic if rains occur following treatment.

THE JAPANESE BEETLE

The main area of Japanese beetle infestation has continued to increase, and serious damage is now being done in the District of Columbia and adjoining sections of Maryland and Virginia, in southern New England and New York State, and at a few points in Ohio. Special emphasis is now being placed upon the work with the milky disease of the Japanese beetle grub, which offers marked promise in the natural control of the insect. A broad program of distribution of this disease has been undertaken, to include an intensive distribution in turf areas in Government-owned reservations where the Japanese beetle occurs and spot colonization on non-Government properties at representative points in the beetle-infested area where the disease is not already present. As a start in the program of treatment of Federal properties, approximately 1,400 acres of turf on Government-owned land in the District of Columbia and adjacent Virginia were treated with spore-dust material during 1940. The program is now being continued in Government properties in a number of other infested areas, and early in 1941 over 3,600 acres of turf land were treated on 35 Government reservations from Virginia to New York.

Cooperation was extended to several State agencies in the production of milky disease material for local use in more intensive distribution over and above the colonization program of the Bureau. The most comprehensive program of this kind has been carried on by the University of Maryland. During 1940 a total of 287,850 milky diseased larvae were received from the University of Maryland and processed at the Bureau laboratory at Moorestown, N. J., to prepare a total of 12,425 pounds of spore-dust material for use in the Maryland work. Studies are being made of the susceptibility to the milky disease of native species of white grubs, which

might permit the establishment of the disease and the building up of reservoirs of infection at points beyond the present spread of the Japanese beetle.

Experiments with Japanese beetle traps in 1940 confirmed the findings made in 1939, which showed conclusively that traps painted yellow are superior in effectiveness to traps of any other color, including those painted green and white as heretofore recommended.

Field collection and recolonization of the imported wasp parasites of the Japanese beetle, *Tiphia vernalis* Roh. and *T. popilliavora* Roh., have been continued. In the spring of 1941, 15,600 female parasites of the first-mentioned species were collected, and 139 colonies containing 14,000 of the parasites were placed at various points in 8 States. During 1940 special efforts were made to survey all the 37 colonies of the Korean strain of *T. popilliavora*, which has been found to be better synchronized with the development of the Japanese beetle in this country than the type strain. Comparison of the dates of field appearance of this strain in 1940 with those of the type strain indicate that this strain has still retained its habit of emerging from 10 to 14 days later than the type. The late appearance of this species should be beneficial in synchronizing it with the proper stages of the host.

THE PEAR PSYLLA IN THE NORTHWEST

Continued intensive scouting has revealed that the distribution of the pear psylla in the Pacific Northwest extends beyond the limits of the Spokane Valley. Intensive surveys carried on in British Columbia by the Canadian authorities have not brought to light any infestation north of the border. No infestation has been found in the main pear-producing areas of the Wenatchee Valley. Two very light infestations which were found late in 1940 in the Peshastin and Mission Creek Canyons west of Wenatchee have not reappeared this season, following an intensive spray program late in 1940 and early in 1941. The two infestations found in 1941 south of Wenatchee are isolated from the pear-producing sections by several ridges and are receiving the suppressive spray treatments.

The infestation is quite general in the area surrounding Spokane, Wash., and in a small area north of Pend Oreille Lake in Idaho. In these areas, however, there are very few commercial pear orchards, and the infestations occur chiefly in dooryard trees or home orchards.

The increase in the areas known to be infested is largely a reflection of the more intensive nature of the scouting and the increased efficiency of the scouts as the organization has been built up and trained. Many of the infestations that have been brought to light have been evidently of several years' standing, and it is believed that only a small part of the extension of the known infested area represents spread since the discovery of the pear psylla in 1939. The control measures consist largely in spraying. The pear trees receive an application of oil during the late dormant period just before and as the buds push out. This is followed by several successive applications of nicotine, usually with a highly refined summer oil, but sometimes with soap or with lime, as the successive broods of the pear psylla come along. By this means many of the infestations in which the insects were very abundant when first discovered have

been reduced to a very low point, minimizing the danger of spread. Many of the lighter infestations have not reappeared following the intensive spray program.

This Bureau is cooperating in the maintenance of State quarantine and regulatory measures in Washington and Idaho to prevent the possible accidental movement of the pear psylla to uninfested territory in various farm products grown in or close to infested pear orchards. Many infested dooryard or home-orchard trees and abandoned trees of no commercial value have been removed by State agencies, or by the owners themselves, thus eliminating them as sources of further spread.

HALL'S SCALE IN CALIFORNIA

Hall's scale (*Lepidosaphes halli* Green) made its reappearance in 1940 in an almond orchard at Chico, Calif. It is thought that the original infestation in the Plant Introduction Gardens at Chico was cleaned up and that later the infestation in the nearby almond orchard built up to the point of spread and reinfested the gardens. The Bureau has received from appropriations provided under the general authorization for the control of incipient and emergency outbreaks of insect pests and plant diseases an allotment to attempt the eradication of the present infestation. This effort on the part of the Bureau is in cooperation with the California State Department of Agriculture, the Bureau of Plant Industry of the United States Department of Agriculture, and the owners of infested properties.

FRUITFLY INVESTIGATIONS

Laboratory studies on a new poison for the Mexican fruitfly show that ½ ounce of it is as effective as 2 pounds of tartar emetic, the best poison now available. A new formula for the Mediterranean fruitfly lure has increased the catch more than 100 percent. In the vapor-heat sterilization of fruit a reduction to 60 percent relative humidity in the approach period, as proposed by those interested, has been shown to retard the process by a period of 2 hours. Fumigation studies on fruits and vegetables have been shifted to treatment after the products have been wrapped and packed, for comparison with results on trial shipments treated before packing. An apparatus for the laboratory duplication of the march of climatic humidity has been perfected. A new cooperative project has been undertaken with the Canal authorities in the Canal Zone.

MEXICAN FRUITFLY CONTROL

INFESTATIONS

For the second consecutive year larval infestations of the Mexican fruitfly in Texas citrus fruits were approximately 25 percent of the number recorded two seasons ago. At no time during the harvesting period from September through May did there develop a serious outbreak of the pest which was not readily controlled by the measures now in force. Fruitfly recoveries from traps were only about one-sixth as high as for last season.

Table 1 shows, for the fiscal years 1935 to 1941, the number of infestations in relation to the number of flies trapped and the dates the harvesting seasons closed.

TABLE 1.—*Infestations of the Mexican fruitfly in Texas, fiscal years 1935–41*

Fiscal year	Flies trapped	Larval infestations	Harvesting season closed	Fiscal year	Flies trapped	Larval infestations	Harvesting season closed
	Number	*Number*			*Number*	*Number*	
1935	367	30	Apr. 2.	1939	13,687	2,141	May 15.[1]
1936	251	5	Mar. 31.				June 15.[2]
1937	4,714	1,062	Do.	1940	6,157	[3] 582	Apr. 30.
1938	712	218	Apr. 30.	1941	979	552	May 31.

[1] For grapefruit.
[2] For oranges.
[3] Including 4 infestations in fruit of 1939.

STERILIZATION

Although there was a slight reduction in the number of infestations discovered the past season, there was an increase of approximately 1,000 tons in the amount of grapefruit sterilized by the high-temperature method. There was, however, a decrease in the amount of fruit sterilized by the low-temperature method.

Fruit is sterilized through the vapor-heat method by raising the inside temperature of the fruit to 110° F. and holding the fruit at this temperature for 6 hours. Throughout the time the fruit is receiving this treatment, air with 100 percent humidity must be forced through the room and around the fruit. This humidity is obtained by injecting steam into the air-conditioning unit. Sterilization is also possible by reducing the inside temperature of the fruit to 30°–31° F. and holding it at this point for 15 days. This process is rarely used, owing principally to the time involved.

Table 2 lists the amounts of fruit sterilized by these two methods in the fiscal years 1939, 1940, and 1941.

TABLE 2.—*Citrus fruit sterilized in Texas, fiscal years 1939, 1940, and 1941*

Fiscal year	By high-temperature method		By low-temperature method	
	Grapefruit	Oranges	Grapefruit	Oranges
	Tons	*Tons*	*Tons*	*Tons*
1939	44,150.0	2.25	2.08	0
1940	8,926.9	.75	298.6	168.8
1941	9,936.8	0	53.6	0

FRUIT PRODUCTION AND SHIPMENTS

All grapefruit and oranges produced in the area regulated under Quarantine 64 are harvested and shipped under permits and are certified for movement only after careful inspection.

The Texas citrus-fruit production for 1940–41 was 2,257 equivalent carlots less than last season's total.

Fruit shipments and total production for the last nine seasons are listed in table 3.

TABLE 3.—*Citrus fruit from the Rio Grande Valley of Texas, shipped and canned, and total production, in equivalent carlots, fiscal years 1933–41*

Fiscal year	By rail		By truck		By boat		By express and passenger car mixed	Canned grapefruit	Commercial production
	Grapefruit	Oranges	Grapefruit	Oranges	Grapefruit	Oranges			
	Carlots	*Carlots*	*Carlots*	*Carlots*	*Carlots*	*Carlots*	*Carlots*	*Carlots*	*Carlots*
1933	2,897	230	880	586	----------	----------	101	127	4,821
1934	1,748	114	1,236	877	----------	----------	99	240	4,314
1935	4,617	225	1,731	1,095	----------	----------	239	1,131	9,038
1936	4,262	600	1,454	1,182	----------	----------	267	1,682	9,447
1937	15,616	2,729	2,578	2,351	176	17	532	[1] 6,702	30,701
1938	13,736.3	1,322.7	2,817.4	1,991.5	183.1	4.7	593.1	14,278.6	34,927.4
1939	16,571.6	1,938.5	5,868.3	5,399.3	521.5	12.2	626	[2] 16,611	47,548.4
1940	12,758.5	1,323.9	7,239.0	4,734.2	579.5	3.0	600	[3] 19,217.3	46,455.4
1941	9,769.4	1,134.8	10,075.4	5,652.8	63.3	1.7	860	[4] 16,640.9	44,198.3

[1] Includes 2 cars of oranges processed.
[2] Includes 35 cars of oranges processed and 4,304 cars of grapefruit for diversion under Federal Surplus Commodities Corporation program.
[3] Includes 84.6 cars of oranges processed.
[4] Includes 45.4 cars of oranges processed.

NATIONAL DEFENSE

Early in the fiscal year it became apparent that more than the usual cooperation between the various governmental agencies operating in the Rio Grande Valley was desirable. Accordingly, conferences were held and definite arrangements were made with the Treasury Department for the Border Patrol to share the facilities of two new road stations which were being constructed by this Division. By locating these road stations at points satisfactory to both agencies, traffic moving to and from the Valley area can be stopped and inspected with little extra delay.

To be of as much service as possible during the present emergency, this Division placed at the disposal of the United States Army Engineers surplus motor equipment temporarily needed by them. From time to time during the year this Division has had opportunity to assist in various ways other divisions of the Bureau as well as other departments of the Government.

JAPANESE BEETLE QUARANTINE AND CONTROL

TRAP SCOUTING IN NONREGULATED TERRITORY

Trap scouting to determine the spread of the Japanese beetle in unquarantined States and in nonregulated portions of infested States was carried on during the summer of 1940 in 490 localities in 39 States. Trapping was begun on April 15 and concluded on September 30. During the season 83,019 traps were operated, most of them for periods of 30 days each. There were only 4 nonquarantined States in which trapping was not performed, viz, Montana, Nevada, Oklahoma, and South Dakota. At the peak of the season there were 366 trap inspectors.

Beetles were trapped in 131 communities in 16 States. These States, with the number of communities trapped in each, are as follows: Florida 3, Georgia 5, Illinois 3, Indiana 9, Kentucky 1, Maine 2, Maryland 41, Michigan 2, Missouri 2, New York 5, North Carolina 20, Ohio 11, Pennsylvania 5, South Carolina 3, Virginia 13, and

West Virginia 6. Fifty-six of the positive catches were first records; 75 were recurring infestations carried over from small infestations of previous years. Of these infestations, 42 were incipient or negligible and could safely be ignored for the time being. Forty of the isolated infestations have been treated with lead arsenate. An additional 44 were brought within the regulated territory in the revision of the quarantine regulations of February 12, 1941. Another is subject to rigid State quarantine. The remaining 4 were permitted to remain outside the regulated area under safeguards to permit further suppressive work in connection with the Maryland retardation campaign.

Trapping was with negative results in 23 States, in which 1,803 traps had been set in 134 communities. These States, with the number of communities trapped in each, are as follows: Alabama 5, Arizona 8, Arkansas 1, California 14, Colorado 2, Idaho 4, Iowa 1, Kansas 1, Louisiana 7, Minnesota 3, Mississippi 4, Nebraska 1, New Hampshire 7, New Mexico 4, North Dakota 1, Oregon 4, Tennessee 3, Texas 42, Utah 5, Vermont 6, Washington 6, Wisconsin 4, and Wyoming 1. Trapping also yielded negative results in 225 localities in States in which beetles were caught.

In Georgia 3,109 traps were set in Atlanta and 32 beetles were trapped; 440 traps were set in East Point, a suburb of Atlanta, and 137 beetles were caught. First-record captures included 17 beetles at Chamblee, 2 at Gainesville, and 2 at Toccoa. Eight other localities in the State were trapped with negative results.

In Illinois 10,000 traps were set in Chicago, resulting in the capture of 462 beetles. This was a decrease of 87 beetles as compared with 1939. At East St. Louis 600 traps were set and 5 beetles caught, a decrease of 19 as compared with last year. There were no captures in Cicero and Evanston in 1940, where 2 and 16 beetles were trapped in 1939. A first-record capture of 1 beetle occurred at Oak Park. Six other localities were trapped with negative results.

In Indiana trap scouting was conducted in 23 localities, with positive results in 9. A first-record infestation of 2 beetles was found at New Castle. No beetles were trapped in Bluffton and Hammond, where 2 and 3 beetles, respectively, were found last year; but in Richmond 7 beetles were captured, an increase of 6, and in Warsaw 60 beetles were caught, an increase of 58 over the first-record infestation of last year. Other beetle captures this year, as compared with 1939, increased from 5 to 77 in Elkhart and from 76 to 160 in Indianapolis and decreased from 105 to 52 in Fort Wayne, from 98 to 13 in Logansport, and from 18 to 4 in Whiting.

In Kentucky 1,200 traps were set in Louisville and 4 beetles captured, a decrease of 9 as compared with the 13 beetles found in 1,600 traps last year. Two hundred traps were set in Frankfort, with negative results.

In Maine 1,158 traps were operated in 15 localities in the nonregulated section; 325 of these were set in Bangor, where 9 beetles were captured, an increase of 4 over the number caught last year. A first-record infestation of 4 beetles was found at Bar Harbor. No beetles were captured in the other 13 localities trapped.

Maryland State authorities in charge of the cooperative retardation program distributed 54,612 traps in cities and towns throughout

the heavily infested portions of Maryland. A total of 36,491 quarts of beetles were caught. In addition, traps distributed on farms caught 881,716 quarts of beetles, making a grand total of 275.4 tons of beetles trapped in the State. Captures ranging from 3 to 33,000 beetles were made in 41 localities in the then nonregulated territory. First-record captures were made in 30 localities in the State.

In Michigan, from July 16 to August 23, 6,000 traps were set in Detroit and 252 beetles were captured, an increase of 137 over the number caught with 5,250 traps in 1939. At Melvindale 1 beetle was caught as compared with 5 trapped last year. Trapping with negative results was performed in Birmingham, Dearborn, Escanaba, Grosse Pointe Farms, and Newaygo.

In Missouri 14,083 traps were operated, of which 12,299 were in St. Louis, where 30 beetles were caught, an increase of 4 over the number trapped last year. One beetle was captured at Lambert Field (Bridgeton-St. Louis), where 51 traps had been set. Negative results were obtained from the remaining 1,733 traps, which were distributed among 11 localities.

In New York the operation of 1,807 traps in 24 localities resulted in the capture of 71 beetles in 5 localities. The infestation of 6 beetles at Dansville was a substantial decrease under the 116 beetles caught there in 1939. Other decreases occurred in Geneva, where 5 beetles were captured as compared with 15 last year, and in Canandaigua (2 beetles as compared with 5). Increased infestations occurred in Auburn (37 beetles as compared with 11) and in Newark (21 as compared with 2).

In North Carolina 9,181 traps were operated, in which 21,368 beetles were captured in 20 localities. First-record infestations occurred in Tarboro (1 beetle) and Weldon (3 beetles). The Asheville infestation increased to 19,322 beetles as compared with 1,073 in 1939. As it was impractical to treat this isolated infestation with lead arsenate, other suppressive measures were carried on there in cooperation with State officials, and a State quarantine paralleling Federal regulations was strictly enforced.

In Ohio an extensive trapping program was carried on, 5,584 traps being set in 102 localities. Positive results were obtained in 11 localities. First-record finds included 1 beetle at Athens, 3 at Bucyrus, 1 at Norwalk, and 1 at New Concord. Increased infestations occurred at Belpre (191 this year as compared with 124 last year), Conneaut (371 as compared with 184), Gallipolis (769 as compared with 217), and Zanesville (23 as compared with 5). Infestations persisted in Ashtabula, Elyria, and Marietta in about the same numbers as in 1939.

In Pennsylvania 9 cities and towns were trapped, resulting in the capture of 107 beetles at 5 localities. First-record finds were at Grove City, 67 beetles, and Wesleyville, 1 beetle. There were 1,490 traps set in the State.

In South Carolina 1,400 traps were set in Charleston, Florence, and Greenville, resulting in the capture of 12, 8, and 12 beetles, respectively.

In Texas, as in other States west of the Mississippi, the scouting traps were operated by field stations of other divisions of the Bureau. A total of 503 traps were set in 42 Texas localities, with negative results.

In Virginia beetles were trapped in 13 communities as a result of the operation of 1,779 traps in 27 cities and towns in the State. First-record captures were as follows: Courtland (Southampton County) 1, North Emporia 22, South Emporia 18, Strasburg 2, Timberville 1, Washington 978, and Woodstock 5. At Winchester 79 beetles were captured in 400 traps, as compared with 9 beetles in 397 traps in 1939.

In West Virginia 442 traps were distributed among 14 cities and towns. First-record finds were 35 at Benwood, 5 at McMechen, 2 at Paden City, 1 at St. Mary's, and 1 at Sistersville. The only other positive results occurred at Moundsville, where 30 beetles were found as compared with 2 in 1939.

SUPPRESSIVE MEASURES

Large-scale control programs were repeated in the fall of 1940 at isolated infestations. Lead arsenate was applied to a total of 1,013.79 acres in Georgia, Illinois, Indiana, Michigan, Missouri, New York, North Carolina, Ohio, and Virginia.

Reductions in beetle infestations were obtained in the sections treated last year in Atlanta and East Point, Ga. Further treatments of lead arsenate were applied to 14.8 acres in Atlanta and 9.6 acres in East Point between August 14 and September 9. In addition, 6.2 acres were treated in Chamblee.

In Chicago, Ill., 107 acres were treated between August 29 and November 5. Additional treatment was applied there in the spring, when 60.1 acres were treated between May 5 and June 30.

In Indiana lead arsenate was applied to the recurring infestations in Elkhart, Fort Wayne, Indianapolis, Logansport, Richmond, South Bend, and Warsaw. A total of 142.7 acres were treated in these localities. In the spring, between March 31 and April 8, an additional 70.95 acres were treated in Indianapolis, 4.5 acres in New Castle, 0.9 acre in Richmond, and 0.25 acre in Warsaw.

Treatment was applied to 114.85 acres in Detroit and 1.5 acres in Melvindale, Mich.

At St. Louis, Mo., 23.4 acres were treated to cover properties on which 30 beetles were trapped outside the previously treated area.

Treating in Dansville and Newark, N. Y., was sponsored by the local nurserymen and the municipalities concerned, with State and Federal cooperation. Only 1.25 acres were treated in Dansville in view of the decreased infestation, while in Newark, following an increase in the number of beetles trapped, 42.4 acres were treated.

A total of 346.6 acres were treated in 16 communities in North Carolina. For the rather heavy, localized infestation in Asheville, lead arsenate treatment was impracticable owing to the presence of cultivated fields and considerable wild growth in the section involved. Consequently a combined program of milky disease inoculation and intensive trapping to catch any escaped adults was carried on there, beginning in May.

In Ohio the large-scale treating program was repeated, with 165.49 acres covered between October 10 and November 27. Treatment was applied in Ashtabula, Belpre, Conneaut, Gallipolis, Marietta, and Zanesville, the same communities as last year.

At Danville, Va., 38 acres were treated between October 17 and November 20 under State and municipal auspices.

All treatments during the fall of 1940 and spring of 1941 were at the rate of 500 pounds of lead arsenate per acre, a reduction of 500 pounds in the dosage formerly required. As in previous years, the treating work has been carried on in cooperation with the various States, this Bureau furnishing the spray trucks, truck drivers, and a supervisor to cooperate with the State official directly in charge of the treating.

FEDERAL AND STATE REGULATORY MEASURES

A revision of the Japanese beetle quarantine and regulations, effective February 12, 1940, extended the regulated area to include new areas in Maryland, New York, Pennsylvania, Virginia, and West Virginia. The new areas brought within the regulations include parts or all of the following counties: Baltimore, Carroll, Charles, Dorchester, Frederick, Howard, Montgomery, Washington, and Wicomico, Md.; Cayuga, N. Y.; Butler, Crawford, Erie, Forest, Mercer, Venango, and Warren, Pa.; Chesterfield, Greensville, and Rappahannock, Va.; and Marshall and Ohio, W. Va. The cities of Petersburg and Winchester, Va., are also included. These additions to the regulated area were made because scouting in 1940 showed that beetles were present there in large numbers.

The heavily infested area subject to special regulations on the movement of all fruits and vegetables via refrigerator car and motor truck was extended to include additional areas in Baltimore and Howard Counties, Md., and Berks, Lehigh, Northampton, and York Counties, Pa., and to bring in part of Cumberland County, Pa. Metropolitan New York localities and adjoining territory in Fairfield County, Conn., have been dropped from this area.

In addition, a few minor changes were made in the Japanese beetle quarantine regulations. These cover modifications of the regulations for fruit and vegetable shipments to isolated points and of requirements as to certification of bananas.

Restrictions on the movement of fruits and vegetables under Japanese beetle quarantine regulations were removed for the season on September 19, 1940, it having been determined that the active period of the Japanese beetle in its relation to these products had ceased for the season. Restrictions on cut flowers, however, remained in force through October 15.

Also on September 19, 1940, an order was issued modifying administrative instructions to inspectors on the treatment of nursery products with carbon disulfide emulsion for the Japanese beetle, deleting the requirement that "the soil must not be disturbed for 48 hours." Experience in treating plants in the field with this chemical had proved that the requirement might be safely eliminated.

On September 27, 1940, a revision was made of administrative instructions regarding the procedure for methyl bromide fumigation. This revision modified the dosage of methyl bromide per 1,000 cubic feet according to the temperature and length of treatment.

As a result of further experiments with treatments for freeing nursery stock and potted plants from immature stages of the Japanese beetle, it was found that a dosage of 2½ pounds of methyl bromide per 1,000 cubic feet applied for a period of 3½ hours at a tempera-

ture of not less than 57° F., or for 3 hours at not less than 60° F., is sufficient to kill such larvae. Administrative instructions were accordingly revised, under date of April 11, 1941, to authorize the use of such treatments, in addition to those theretofore provided for.

Effective May 1, 1941, administrative instructions to inspectors on the treatment of nursery products, fruits, vegetables, and soil for the Japanese beetle were modified to reduce the dosage of lead arsenate applied to nursery plots containing growing plants, and to cold-frames, plunging beds, and healing-in areas, from the previous rate of 1,500 pounds per acre to 1,100 pounds per acre (or 26 pounds for 1,000 square feet) for initial treatments. In subsequent retreatments sufficient lead arsenate must be applied to restore a concentration of 1,100 pounds per acre, as determined by chemical analyses, except that determination by chemical analyses of a concentration of 1,000 pounds per acre will be acceptable without retreatment.

HIGHWAY INSPECTION SERVICE

At the peak of the 1940 season 30 road-patrol stations were in operation, 24 of the regular type plus 6 mobile units. Distribution of the stations was as follows: Virginia, 14 regular and 3 floating; West Virginia, 1 regular and 1 floating; Ohio, 9 regular and 1 floating; and Maryland, 1 floating. During the summer the maximum number of road inspectors employed for operation of the posts was 74 in the month of July.

Closing of the regular stations began in September, and by the end of October only two regular stations were in operation, both in the vicinity of Fredericksburg, Va. One of these was discontinued on November 24; the other was continued through the month of December, and one larva in the soil accompanying a fig tree was intercepted at this station in December.

Road-patrol activities in the spring of 1941 began with the opening of two stations in the vicinity of Fredericksburg, Va., one on April 28 and the other on April 30. By the end of May, 5 regular stations were in operation, 4 in Virginia and 1 in West Virginia, 15 men being employed. During June, 14 regular and 1 floater station were in operation in Virginia, with a personnel of 46; 1 post was in operation in West Virginia, employing 2 men; and 4 stations in Ohio, with a total of 17 men assigned.

In the summer of 1940, during the period of heavy adult flight, 4 inspectors were stationed at the large eastern airports in the vicinity of dense Japanese beetle infestations. These inspectors intercepted 311 beetles that were either in planes bound for non-infested States or were on passengers or employees entering planes or on mail or baggage being placed in the planes.

During the year 1,208 empty trucks returning to southern points after driving through infested sections were found to contain 7,899 beetles. Sixty-eight lots of infested plant material were intercepted at the posts, from which were removed 17 adult beetles, 139 larvae, and 5 pupae. Counts of all motor vehicles stopped at the road posts for inspection during the year totaled 3,061,992. Uncertified quarantined products were found in 12,553 vehicles.

CERTIFICATION AND TREATMENT OF NURSERY STOCK

As a result of scouting during the summer of 1940 within the regulated area, 16,907 beetles were found on the premises or within a 500-foot radius of 331 classified nurseries and greenhouses. In the New England States 31 establishments were found infested in Connecticut, 11 in Massachusetts, 1 in New Hampshire, and 2 in Rhode Island. Nurseries found infested in other States in the regulated area were as follows: Delaware 61, Maryland 147, New Jersey 1, New York 29, Ohio 5, Pennsylvania 20, Virginia 20, and West Virginia 3. Twelve sand, soil, peat, and manure establishments were found infested with 235 beetles.

Fourteen nurseries that had been assigned to class III, as the result of one or a few beetles found on the premises in previous years, were rescouted during the summer of 1940 to determine their eligibility for restoration to an uninfested status. Two of these establishments were found free of infestation and accordingly reverted to class I or preferred status. One unit was granted preferred status in part. Nursery and greenhouse scouting was completed by the middle of September, except in one district where scouting was continued until September 21.

Nursery and greenhouse business was good in all parts of the Japanese beetle regulated area, causing increased demands for inspection and certification of nursery and greenhouse stock for shipment. Very good Easter business in 1941 was also reported, many dealers claiming it was their best year since 1929.

During November 1940, arrangements were made for the fumigation, at one of the large Ohio nurseries, of about 10,000 perennials of all varieties and the transportation of these fumigated plants to the Bureau's field laboratory at Sanford, Fla., for planting and observation as to the tolerance of the different species to methyl bromide fumigation. Reports indicated that approximately two-thirds of the varieties survived in such numbers as to suggest that their fumigation under commercial conditions is practicable. In April 1941, additional tests with the plants that did not respond well were made at the nursery. The results tended to show that other factors than methyl bromide caused the poor growth. These results have been compiled along with other reports, as mentioned below.

A supplement to the Japanese Beetle Quarantine Shipper's Guide, listing the towns and cities within the sections added to the regulated area under the revision of the quarantine effective February 12, 1941, was distributed in February.

Supplement 1 to the handbook previously distributed to inspectors, showing construction details for an approved methyl bromide fumigation chamber, was issued in September 1940. The supplement gives details for the construction of a chamber of approximately 200-cubic-foot capacity. It includes a purchase list and a material list, along with detailed drawings of the framing, doors, lining, and electrical wiring and connections.

A commercial can opener made especially for the opening of 1-pound cans of methyl bromide has been adopted for use in connec-

tion with the fumigation of refrigerator cars. This method of application has many advantages, including the saving of time and money and the application of an exact dosage in each car.

During 1940 the increases in nursery-stock certification in New Jersey were as follows: Fumigation of plants and soil, 100 percent over 1939; treatment of azaleas and rhododendrons with para-dichlorobenzene, 111 percent; use of methyl bromide on plants, 74 percent; treating of potting soil with carbon disulfide, 33 percent and surface treatments with lead arsenate, 182 percent.

On June 1, 1941, the Division issued a list of plants that had been treated by methyl bromide fumigation, with reports of injury or noninjury to the plants. The information was obtained from about 30 growers in the Japanese beetle regulated area who had used fumigation chambers. Records appear for 2,024 plants. Reports received indicated injury to 195 plants, or 9.6 percent of the total.

A total of 666 soil samples were collected from nursery plots, heeling-in areas, and frames previously treated with lead arsenate. These samples were analyzed by the Division of Insecticide Investigations, and, as a result of the analyses, 1,046,870 square feet were retreated to bring the insecticide content of the soil up to the required dosage. In addition, initial applications of lead arsenate were made to 1,582,096 square feet of nursery area.

At the end of the year the number of nurseries and greenhouses fulfilling the requirements for classification under the quarantine regulations had decreased from 2,075 to 1,832.

CERTIFICATION OF FRUITS, VEGETABLES, AND CUT FLOWERS

Inspection centers were in operation at 19 points throughout the regulated area during the period of adult beetle flight in 1940. Nine were in Delaware, 1 in the District of Columbia, 4 in Maryland, 1 in New York City, 1 in Pennsylvania, and 3 in Virginia.

Records of certification of farm products in New Jersey for 1940 showed an increase of 97 percent over 1939. This general rise was brought about by the increases in certification of apples and potatoes, these being 227 percent and 123 percent, respectively. The apple crop was smaller but brought better prices and moved earlier than in 1939, thus coming within the regulatory period. Growers of potatoes had a rather unsatisfactory season. Yields were good but prices were low. As a result, the stabilizing effort of the Surplus Marketing Administration's purchasing at low market prices caused an increase in the methyl bromide fumigation of loaded refrigerator cars. The major portion of carlots certified were destined to southern points for relief purposes. The fumigation of farm products in refrigerator cars with methyl bromide ended for the season on September 9.

During the period of the quarantine on fruits, vegetables, and cut flowers, inspectors removed 4,205 beetles from 2,887,574 packages of commodities certified for transportation.

ARTICLES CERTIFIED AND VIOLATIONS INVESTIGATED

A total of 386,595 certificates were issued to cover quarantined products moving to nonregulated territory.

Table 4 shows the quarantined materials intended for shipment from the regulated area or for use in certified greenhouses, as well as the surface soil in nursery plots, heeling-in areas, and plunging areas, which were fumigated or sterilized during the 12-month period.

TABLE 4.—*Materials fumigated or sterilized under Japanese beetle quarantine regulations, fiscal year 1941*

Treatment	Plants	Potting soil	Surface soil	Surface soil with plants
	Number	*Cubic yards*	*Square feet*	*Square feet*
Lead arsenate	241,536		2,597,487	805,802
Carbon disulfide	2,898	2,145	29,634	
Miscible carbon disulfide			1,827	
Paradichlorobenzene	125,491			
Naphthalene		65	59,887	
Steam		28		
Electric heating		8		
Heat		394		

Treatment	Plants	Potting soil	Sweet-potatoes	Onions		Tomatoes	Mixed shipments	Empty cars
	Number	*Cubic yards*	*Cars*	*Cars*	*Bags*	*Cars*	*Cars*	*Number*
Methyl bromide	1,462,909	221	26	12	500	81	4	
Hydrocyanic acid								5,390

Treatment	Lima beans	Cabbage	Potatoes		Apples	Bananas	Turnips
	Cars	*Baskets*	*Cars*	*Barrels*	*Cars*	*Car*	*Car*
Methyl bromide	2	3,360	1,469	17,015	10	1	1

Nursery and ornamental stock, soil, and other materials were certified for shipment from class III establishments in the regulated area during the year in the following quantities:

Plants	number	40,667,748
Sand, earth, and clay	carloads	74
Do	pounds	252,463
Peat	do	5,157
Compost and manure	do	103,009
Leaf mold	do	500
Stolons	square feet	2,455

Fruits and vegetables and cut flowers certified during the seasonal quarantine on these articles were as follows:

Fruits and vegetables	packages	2,854,344
Cut flowers	do	33,230

In addition, 187,714 shipments were made by class I establishments to points in nonregulated territory and to other classified establishments in the regulated area. Furthermore, a total of 26,578,429 plants were certified for shipment between dealers in the entire Japanese beetle area.

Investigations were made of 1,394 apparent violations of the Japanese beetle quarantine regulations. These included interceptions by transit inspectors of the Bureau stationed at postal and common-carrier terminals and by highway inspectors examining road vehicles. No prosecutions of violations were undertaken.

COOPERATIVE ENTERPRISES

State funds for cooperative control of quarantine activities were provided by Connecticut, Delaware, Illinois, Indiana, Maine, Maryland, Massachusetts, Michigan, Missouri, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, Vermont, Virginia, and West Virginia.

Total contributions from State, city, and Federal agencies for trapping and soil treatments during the year amounted to $282,333.

Experimental work with the nematode *Neoaplectana glaseri*, in cooperation between this Bureau and the New Jersey Department of Agriculture, has resulted in the colonization of the nematode in a large number of scattered locations throughout the State.

PARLATORIA CHINENSIS SURVEY

In the spring of 1940 Missouri State inspectors discovered in St. Louis a scale insect, *Parlatoria chinensis* Marlatt, which had not theretofore been recorded as occurring in this country. Because of the possibility that it might be an economic pest, a Federal-State survey of St. Louis and vicinity was made in the winter of 1940–41 to determine the extent of the infestation and the host plants, and to obtain information which might lead to the discovery of possible infestations elsewhere. The survey disclosed that the insects had spread over 109 city blocks and that they were infesting 37 genera of ornamental and fruit plants without seeming to favor any particular plant. The State established a quarantine early in 1941 to help prevent dissemination of the insect.

PHONY PEACH AND PEACH MOSAIC DISEASE CONTROL AND ERADICATION

Through joint activities of the Federal-State pest-control agencies of the last few years substantial progress has been made in the control or eradication of the phony peach and peach mosaic diseases, which have been responsible for heavy losses in the peach crop.

The phony peach disease, once known to exist in 17 States, has apparently been eradicated from Indiana, Maryland, Oklahoma, and Pennsylvania, and greatly reduced in other States, as indicated by the fact that in the inspection during the year no phony trees could be found in 97 previously infected counties in 12 Southeastern States, nor were any newly infected counties found. However, orchards in more than 120 counties were still found to be infected.

The number of mosaic trees found was about 42 percent less than last year. Fourteen previously infected counties were apparently free of the disease, and 5 new counties were found to be infected, making a total of 37 mosaic-infected counties in 7 Southwestern States.

The program of control and eradication had a threefold approach. First, to prevent long-distance spread of these diseases through the shipment of nursery stock containing diseased trees, intensive inspections were made around peach nurseries in the infected States. The shipping of peach stock from areas in which the diseases occur was prohibited by State quarantines unless it was produced under

specified sanitation conditions. In the mosaic area the sources of budwood were also inspected. Second, peach orchard and dooryard plantings were inspected and diseased trees removed as promptly as possible. And, third, to prevent escaped and abandoned trees from becoming harboring places for these diseases, such trees were destroyed by relief crews.

Inspection was made of more than 172,000 properties in over 300 counties of 19 Southern and Western States from the Atlantic to the Pacific. These diseases were found on 5,722 properties. Through allotments of emergency relief funds more than 100,000 diseased trees were destroyed as well as over 3,750,000 abandoned and escaped trees.

In the spring of 1941 the environs of 649 nurseries and of 129 budwood properties were inspected. Only 11 of the nurseries failed to meet the certification requirements of the quarantines.

The industry now recognizes that, with annual inspection and diseased-tree removal, peaches can be produced on a commercial scale in areas where these viruses occur, and as evidence of the confidence of the growers new peach plantings are being made in areas where diseased trees have been removed.

CITRUS CANKER ERADICATION

The outstanding event of the citrus-canker-eradication project during the year was the finding, by a State nursery inspector in January 1941, of citrus canker at Corpus Christi, Tex. The infection, involving 2 properties and 154 trees, was traced to Navasota, in northern Texas, where through inspection by Federal and State inspectors citrus canker was discovered on 355 hedge trees on 6 properties. All the infected trees in both areas were destroyed as well as several thousand citrus hedge trees at Navasota and other Texas areas. Owners of these hedges were very cooperative in the eradication activities.

Not since September 1938 had the disease been located anywhere in the State except for a single tree at Alta Loma, Tex., on which canker was found in December 1940 on a formerly infected property.

Scouting and inspection were conducted during the year, with the assistance of State inspectors, on more than 12,000 properties in 23 Texas counties. On properties found infected in former years repeated search is made in order to find and inspect every citrus plant or seedling reappearing thereon. With such inspection of previously infected properties, and the finding and removal of host trees of the disease in areas contiguous to known or possible centers of infection, it is hoped that early eradication of this disease may be accomplished.

INVESTIGATIONS OF INSECTS AFFECTING FOREST AND SHADE TREES

PROTECTION OF DEFENSE-HOUSING BUILDINGS AGAINST TERMITE DAMAGE

The necessity of providing housing for the many thousands of workers in defense industries and for members of the armed forces has resulted in an unprecedented amount of new construction of low-cost buildings during the last year. The various governmental agen-

cies to which this construction work has been assigned were in general not well acquainted with the termite problem or the preventive and control measures recommended by the Bureau. The increasing number of requests for assistance made it necessary to curtail certain other activities and devote a large amount of effort to cooperative work with the housing agencies in planning and constructing buildings that will be reasonably safe from future infestation by termites.

An illustrated circular specifically designed to meet the needs of defense-housing agencies was prepared and distributed as one step in acquainting the agencies and their architects and contractors with the Bureau's latest recommendations. A supplement was issued later giving a summary of the most important preventive measures discussed in detail in the circular and including several improvements suggested as a result of examinations of projects under construction and discussions with various members of other governmental agencies.

The general use of metal shields on foundations to prevent termites from reaching wood used in buildings is no longer recommended, because recent research and practical experience have shown that it is almost impossible to design and install shields that are effective, especially in low-cost housing where only a minimum of supervision can be given to the work. Present recommendations for new construction place greatest emphasis on maintaining conditions that will prevent large populations of termites from developing in the soil and on the use of foundations that are impervious to termites. The importance of annual inspections to detect evidence of infestations and the prompt application of control measures where necessary is also being stressed. This new policy has been favorably received by architects and contractors and is being adopted for most of the current construction in defense housing.

Bureau employees visited a total of 122 defense-housing projects during the last half of the year. Many suggestions were made for improving the termite-preventive features of the construction, in some cases resulting in considerable saving in initial cost. This was especially true where the original plans called for the use of metal shields. Elimination of the shields, which are usually made of copper or galvanized iron, served to aid in conserving these high-priority metals without unduly increasing the hazard of termite infestation.

Where the Bureau's recommendations have been followed there will be very little future infestation or damage by termites. This will result in great savings in expenditures that otherwise would be necessary for repairs and the application of control measures. This assistance has been greatly appreciated by the War and Navy Departments, United States Housing Authority, Public Buildings Administration, Federal Works Agency, Federal Housing Administration, and Farm Security Administration.

Cost limitations imposed by the legislation authorizing defense-housing construction and the pressure for speed in completing these projects often make it impossible for the responsible agencies to follow all the Bureau's recommendations. This was especially true during the early part of the program. Consequently there is certain to be a considerable amount of termite infestation in many of the buildings and an increasing demand for technical advice and assistance in making inspections to detect such infestations and in apply-

ing control measures. Research on control methods to meet this need is being carried on as rapidly as possible.

CONTROL OF POWDER-POST BEETLES

Unusually large quantities of crude and finished hardwood products, such as gunstock blanks, are being stored at Army and Navy supply depots and arsenals as a part of the national defense program. Much of this material will be subject to infestation by powder-post beetles unless proper precautions are taken. The Bureau has therefore prepared a new circular for use by defense agencies in which the latest information on preventive and control measures is given. This information is based on the results of research completed in 1940 which was conducted in cooperation with the hardwood-lumber industry.

CONTROL OF PINE BARK BEETLES BY SANITATION-SALVAGE LOGGING

The managers of Federal forests and private timberland owners in northeastern California and southeastern Oregon are manifesting increasing interest in sanitation-salvage logging of susceptible trees as a method of controlling the western pine beetle in mature ponderosa pine. This method has been developed as a result of research conducted over a period of years in northeastern California and gives promise of being one of the most important developments of recent years in the protection of these forests and in permitting the fuller utilization of the available supply of mature ponderosa pine, which is sorely needed in the national defense program.

The first test of sanitation-salvage control was made by the Forest Service on the Blacks Mountain Experimental Forest in 1937. For three successive seasons this project has now shown promising results on this area with a reduction of insect-caused losses ranging from 70 to 90 percent. One private lumber company has been using the method in its own timber since 1938 to determine both its cost and its effectiveness. In the spring of 1941 the Forest Service consummated a sale of stumpage to a private logging concern on the Plumas National Forest under a contract providing for a light cut to remove high-risk trees. This sale calls for the logging of 20 million board feet on an area of 7,000 acres during the season of 1941 and will provide a fairly adequate test of the method under the practical conditions of competitive logging.

A private timber company in southern Oregon put this method to a practical test on a 1,000-acre tract under the Bureau's direction and guidance. Trees showing high risk of imminent beetle attack were marked for cutting, and 18 percent of the stand was thus logged and salvaged. This treatment not only resulted in nearly complete beetle control the first year, but was carried out with a substantial margin of profit to the company. The preliminary results of this work have been so encouraging that the company has extended sanitation-salvage control operations to an additional 5,000 acres for the current year.

Insistent demands are being made for similar studies in other parts of the ponderosa pine area and also in the white pine area of the Northwest. Additional research will be necessary to serve as a basis for applying these principles in these areas and to other species of

trees. The problem is particularly difficult in stands of western white pine because this species commonly occurs in mixture with other species.

BARK BEETLE SURVEYS AND CONTROL

The usual program of bark beetle surveys was continued throughout the pine forests of the Western States insofar as funds for this work were available. Only a few local outbreaks of the western pine beetle were found in California, but there was a general increase in infestation in Oregon and Washington, where a total of 125,000 acres were designated for treatment by direct control methods. Extensive surveys of parts of the Rocky Mountain region revealed general improvement in bark beetle conditions, as a result of the intensive control work of the last few years. Outbreaks of the Black Hills beetle on the Powell National Forest and of the mountain pine beetle on the Wasatch National Forest in Utah and the Coeur d'Alene National Forest in Idaho were still active and being fought by the Forest Service with the technical assistance of the Bureau. Part of the control work on the Coeur d'Alene and Wasatch Forests involved the use of penetrating oil instead of the usual burning method, and very satisfactory results were obtained.

COMPLETION OF HAZARD INVENTORY IN CALIFORNIA

One of the outstanding accomplishments in the work against forest insects was the completion and release of a very comprehensive report on the hazard-inventory survey conducted in California. Data obtained in this survey show that about 11½ billion board feet of ponderosa and Jeffrey pine have died as a result of attack by the western pine beetle during the last 15 years. This is more than the amount cut for lumber during the same period. The survey also shows that a considerable part of the remaining stand is in an insect-susceptible condition and likely to die within the next few years unless weather conditions and other factors affecting the vigor of the trees make a decided improvement in the stand. This report will serve as a basis for the planning of lumbering and timber-management operations so as to remove this susceptible timber before it is killed and before its market value has deteriorated.

ELM BARK BEETLES TRAPPED IN CHEMICALLY TREATED TREES

Emphasis has been placed on methods of controlling elm bark beetles that are responsible for the spread of the Dutch elm disease. One of the most important advances has been the development of suitable trap trees for these beetles by the injection of sodium chlorate with a small amount of sodium arsenite into a few living trees. The sodium chlorate makes the trees very attractive to the bark beetles, but after the beetles attack the trees they fail to develop new broods because of the lethal action of the sodium arsenite on the young brood. It is therefore unnecessary to remove and destroy the infested trees unless the presence of the dead trees is objectionable. If this method of treatment can be applied under practical field conditions, it may be possible to reduce the bark beetle population to a point where further rapid spread of the Dutch elm disease can be controlled.

EFFECTIVENESS OF CONCENTRATED SPRAY AGAINST THE WHITE-PINE WEEVIL

The white-pine weevil is the most serious insect pest of eastern white pine. It attacks white pine and Norway spruce wherever they are grown in the Northeast, causing deformed trees of low commercial value. Experimental work in 1940 showed that excellent control can be obtained by spraying the leaders of the trees in the fall, or prior to egg laying in the spring, with a concentrate containing 14 ounces of lead arsenate and 3½ ounces of fish oil per gallon of water. This concentrate is applied at the rate of about 4 gallons per acre by means of a knapsack sprayer equipped with an extension rod to which is attached a special nozzle that produces a fine, narrow, solid-cone type of spray. The total cost of treatment is about $2 to $2.50 per acre.

The results of this spraying have attracted much attention, and during the spring of 1941 several hundred acres were treated in New York State and Connecticut, and smaller areas were treated in Massachusetts and New Hampshire. This is not intended as a substitute for silvicultural methods of control, but it does seem to make possible, at a not prohibitive cost, sufficient control to permit a fair number of crop trees per acre to mature.

COMPLETION OF STUDY OF THE HEMLOCK BORER

A 4-year study of the hemlock borer infestation on the Menominee Indian Reservation in Wisconsin was completed, and a report on part of this work has been published. The study demonstrated that the hemlock borer injury is secondary and that the mortality in these stands is due primarily to drought and overmaturity. A method of distinguishing trees most likely to die within the next 2 years was developed and is being applied in connection with selective cutting operations on this area. The study also showed the part played by root injury in the decadence of mature hemlock stands.

STUDY OF PLANTATION INSECTS IN THE LAKE STATES

The completion of the hemlock borer study in 1940 made it possible to begin much-needed work on insects that have been causing severe damage in the many thousands of acres of young pine plantations in the Lake States. The Federal Government has an important investment in these plantations which must be protected. Direct control measures are being applied where possible, but there is urgent need for a better understanding of the ecological factors affecting the trees and insects, to serve as a basis for cultural operations that will reduce the need for such control. A project designed to provide this type of information was begun in the spring of 1941 on the Manistee National Forest in Michigan. Several species of pine sawflies, the pine chafer beetle, and the white-pine weevil attacking jack pine are being given first attention.

LOCUST BORER ATTACK ON SPROUT GROWTH OF BLACK LOCUST

Studies, which have been in progress for several years, of the degree of resistance of sprout growth to attack by the locust borer now indicate the limitations of this method of reducing borer injury. Many of the trees under observation in Ohio and Illinois have

reached the diameter above which borer injury is normally more prevalent. Borer populations have been very low in the young sprout stands since the clear cutting of the original heavily infested trees but are now increasing rapidly. Sufficient time has elapsed for the period of rapid sprout growth to be about ended, and future growth may be expected to be about the same as for normal trees. It is now apparent that coppice, or sprout, stands of black locust will be successful only on the better sites.

EUROPEAN SPRUCE SAWFLY

As reported last year, a disease caused a high mortality of spruce sawfly larvae in certain areas in 1939. This disease was prevalent in 1940 throughout the infested areas in Vermont, New Hampshire, and Maine, as well as in New Brunswick, and resulted in a great reduction in the sawfly population. Observations during the early part of the summer of 1941 indicate that the disease is still active and that very few larvae will mature. It therefore appears that the outbreak is at an end.

INSECT VECTORS OF THE PHLOEM NECROSIS DISEASE OF ELM

The search for the vector of the phloem necrosis disease of elm continues. Tests made during 1940 involving 11 species of elm insects, mainly of the sucking type, have not yet produced results, since the period between inoculation and symptom expression may be 1 year or longer. Additional species are being tested this season. Detailed studies in observation plots in Ohio during 1940 showed that the majority of the insect species used in transmission studies were primarily inhabitants of elm or other tree species. Collection data show that other insect species, not yet tested, are found on elm in sufficient numbers to necessitate tests as possible vectors. Data have been accumulated showing seasonal sequence, relative abundance, and food-plant associations of elm insects, which will prove valuable in correlation studies when the vector of the disease is determined.

GYPSY AND BROWN-TAIL MOTH CONTROL

The gypsy moth kills a great variety of fruit, shade, ornamental, and forest trees by defoliating them. During June and the early part of July large woodland areas in New England consisting of a high percentage of the favored food-plant trees are often defoliated so severely that they have the appearance of having been burned by fire. The work of the Bureau to prevent the spread of this insect is carried on to protect the States not now infested. The gypsy moth work by the C. C. C. gives protection to the barrier zone work of the Bureau and cooperating States.

The supervision of the gypsy moth control and extermination work, together with a part of the current operating expenses, is financed by regular Bureau funds, while the cost of labor and a part of the supplies were provided this year, as in recent years, by the W. P. A. allotments. Some of the States, notably New York and Pennsylvania, furnished men and materials as a part of their cooperation in this project.

Valuable time was lost in getting W. P. A. projects started. As the work progressed there was increasing difficulty in securing referrals from the W. P. A. offices in order to keep the force at the estimated level for the year. W. P. A. employees left the work in large numbers to secure private employment, which made it necessary constantly to train the men who were supplied as replacements. These factors prevented completion of the program originally planned. Of the W. P. A. funds 90.5 percent were paid for personal services to an average force of 880 workers, of whom more than 98 percent were certified relief cases.

During the first part of July 1940, temperatures in New England were slightly below normal. August was the driest month on record, and in some areas frosts occurred. September and October were the coldest of these months for the last 15 years. During the remainder of the winter temperatures were comparatively mild, although barrier-zone temperatures reached as low as −30° F. locally in western Massachusetts and northern Vermont.

The deposition of egg clusters in the summer of 1940 covered an unusually long period. Normally most of them are laid before the first of September, but reports were received of female moths laying eggs throughout that month and in a few cases as late as October 14 in Berkshire County, Mass. There was considerable mortality in the clusters deposited abnormally late, and from the examination of a number of collections made in widely scattered towns in New Hampshire, Vermont, western Massachusetts, and western Connecticut it was determined that nearly 27 percent of the eggs would not hatch. The lowest mortality occurred in Connecticut.

Most of the egg clusters hatched abnormally early in the spring of 1941, in some cases about 2 weeks earlier than usual. This hatching period was followed by prolonged cold weather, and many of the larvae either died in the eggshells or were weakened to such an extent that they did not develop. This condition occurred in many areas and reduced the population so that in many sections of the infested territory the insect failed to increase normally.

In the summer of 1940 all available assembling cages were placed in the field. In New York the State Conservation Department and in New Jersey the State Department of Agriculture cooperated in setting up and patrolling the cages. The supply was smaller than usual, but 294 were placed in 13 towns in New York in territory directly west of the Hudson River, 95 in 2 towns in northeastern New Jersey, and 796 in parts of 6 townships along the eastern border of the lightly infested area in Pennsylvania. No male moths were attracted to any of these cages in New Jersey or Pennsylvania, but 3 males were found at 2 cages near Ramapo, N. Y., and 1 new egg cluster was found and treated during the winter. In all, 198,786 female pupae were collected, and the moths emerging from them produced 2,305 charges of attractant for use in the cages in 1941.

Attempts to record defoliation by use of the autogiro during the summer of 1939 proved impractical on account of the impossibility of accurately determining small percentages of defoliation, and, as a result, this method of survey has not been continued. In New England gypsy moth defoliation during the summer of 1940 was

decidedly uneven over a large part of the infested area. Defoliation did not reach its height until considerably later than usual, and this may be explained by late hatching and by cool, wet weather, which delayed development of larvae. For the infested area as a whole, defoliation was somewhat less extensive during the summer of 1940 than during the previous season. The total number of acres of woodland showing from slight to complete defoliation was 485,636. For Maine there was a slight increase in the total acreage showing defoliation, and a marked increase over the previous year was recorded for New Hampshire. For the States of Vermont, Massachusetts, and Rhode Island there was somewhat less defoliation than the year before. No defoliation was reported from any of the towns lying within the barrier zone in Vermont, Massachusetts, Connecticut, or New York, nor was any noticeable defoliation reported from Connecticut east of the zone. Likewise, no defoliation was reported from New York west of the zone or from New Jersey or Pennsylvania.

GYPSY MOTH WORK IN THE BARRIER ZONE AND ADJACENT TERRITORY

In addition to an intensive examination of the sites of previously discovered infestations, scouting was performed in areas considered most important where no work was done during the fiscal year 1940. In the New England section of the barrier zone small scattering infestations were found and treated in most of the towns where scouting was done, from Bristol in Addison County, Vt., south to the Litchfield-New Haven County line in Connecticut. More infestations were found in the Massachusetts portion of the zone than in Vermont and Connecticut, largely because the supply of relief labor was greater, making it possible to cover a considerably greater acreage than in the 2 other States. The size and general distribution of infestations found and treated in Rensselaer and Columbia Counties, N. Y., were comparable with those found in adjacent territory in Berkshire County, Mass. On account of the scarcity of relief labor in northwestern Connecticut much urgently needed work could not be done. As a result of the intensive scouting and treatment work, including spraying, carried on last year in the town of Southbury in New Haven County, Conn., only 44 egg clusters were found and destroyed at the site of the isolated infestation where 16,433 egg clusters had been located and treated during the fiscal year 1940.

Tests and demonstrations have been carried out with spraying equipment designed to operate in an autogiro, powered from the autogiro engine, and so constructed that lead arsenate dust is impregnated with fish oil as these materials are atomized and discharged from the machine. During June 1941 this equipment was used for treatment work in the barrier zone in Vermont, Massachusetts, and Connecticut in infested wooded areas remote from roads and where extremely long hose would have been required if an attempt had been made to use ground machines. A total of 593 acres were treated at the rate of 30 pounds of lead arsenate per acre as follows: In Connecticut 222 acres, in Massachusetts 184 acres, and in Vermont 187 acres. The results have demonstrated that this equipment can be used successfully in remote woodland areas, and it will probably become a useful adjunct to the spraying equipment of this project.

East of the barrier zone only a limited amount of scouting and treatment work was done in Vermont and Connecticut, and the work in Massachusetts was largely confined to scouting, creosoting of egg clusters, selective thinning of favored food species, and spraying at sites of infestations found in the woodland areas bordering the barrier zone where danger of wind spread into the zone seemed greatest. Since relief labor was scarce, no workers were referred to this project for assignment in the field in Franklin County, Mass., after supplemental W. P. A. project funds were made available in the spring, and only one small crew of workers was assigned to this project for work in Hampshire and Hampden Counties. Because of this it was not possible to accomplish as much as was anticipated, especially in the spraying of infested localities discovered during the fall and winter months.

In the New York territory immediately to the west and south of the barrier zone W. P. A. and C. C. C. workers and New York State employees located and treated small scattering infestations in Ticonderoga, Essex County; Hague, Warren County; Half Moon, Saratoga County; Colonie, Albany County; Esopus and Shawangunk, Ulster County; Ramapo, Rockland County; and in Oyster Bay in Nassau County on Long Island. In the areas previously infested there was considerable reduction in the number of egg clusters located and treated this year. This was particularly true in Esopus, where an infestation consisting of 4,582 egg clusters in 1940 was reduced to 508 in 1941 by intensive scouting and treatment. No infestation was found in the Westchester County towns where work was performed during the year.

In New Jersey no Federal work was performed during the year, but a small force of State employees did a limited amount of check-up work in specially selected areas in 13 of the 21 counties in the State. In doing this approximately 11,600 fruit and shade trees in open country and about 5,390 acres of woodland were examined. No evidence of the gypsy moth was found.

GYPSY MOTH WORK IN PENNSYLVANIA

In Pennsylvania there was delay in securing authority to start the W. P. A. project, and field work was not resumed until August 12, 1940. Because of this, very little benefit was obtained from more than 514,000 burlap bands which had been applied during May and June to trees in infested areas that could not be sprayed. Scouting and treatment, including creosoting, thinning, and spraying, were confined to the area under quarantine in Lackawanna, Luzerne, Carbon, and Monroe Counties. Sites of the infestations of 1940 were intensively scouted, and treatment was applied where necessary. Territory contiguous to that examined in 1940 was also scouted and treated insofar as available funds and labor would permit. The 6-week delay experienced in starting W. P. A. work at the beginning of the fiscal year, the heavy turn-over in labor, when work was resumed, which made it necessary continuously to train inexperienced workers in scouting methods, and the inability, in spite of all effort, to secure the labor for the supplemental W. P. A. project from March 1 to May 22, 1941, made it possible to complete only 57 percent of the scouting planned. A record of the work accomplished will be found in table 5.

Federally sponsored National Youth Administration projects, set up on the basis of furnishing the equivalent of a total full-time service force of 100 workers, operated in the field throughout the year in Luzerne and Lackawanna Counties. A Luzerne County shop project was also approved providing for the equivalent of full-time service of 5 workers for duty in the repair shop at Wilkes-Barre. Although most of the workers furnished were inexperienced, close supervision was given them, and reasonably satisfactory results were accomplished both in the field and in the shop.

A State-sponsored Department of Public Assistance project promising 800 man-hours of labor weekly operated intermittently from late in October to the first half of May, furnishing only 9,382 man-hours of employment, which was far short of that promised in the approved application. The labor was inexperienced and was used only for thinning work at sites of known infestations located within 1 mile of the point of assembly for the workers.

Strict enforcement of the Pennsylvania gypsy moth quarantine has continued under the immediate direction of the State official stationed at Wilkes-Barre, so that close cooperation could be maintained between this Bureau and the Pennsylvania Bureau of Plant Industry. He has been assisted by 4 regular Federal employees of this project in immediate charge of the 4 quarantine districts, as well as by less experienced State and W. P. A. employees, depending on the needs of the work. During the year, 13,364 shipments were allowed to move on permits after a careful check-up at point of origin clearly indicated that there was no danger that infestation would be spread as a result of the movement of restricted materials. There were also 20,075 shipments originating in the generally infested area that were inspected and certified as free from the gypsy moth. In this work 109 egg clusters, 154 larvae, and 6 pupae were located and destroyed on the 42 shipments found to be infested. The State issued warnings to 59 first-time violators of the quarantine who were not thoroughly familiar with the State quarantine regulation, and successfully prosecuted 4 individual violators who failed to heed previous warnings.

INFESTATIONS ERADICATED

As a result of intensive scouting during 1941 at sites of infestations discovered in the New England barrier zone area and in New York and Pennsylvania during the fiscal year 1940, it has been determined that 103 infestations have been eradicated. Of this total, 22 infestations have been wiped out in Vermont, 15 in Massachusetts, 21 in Connecticut, 1 in New York, and 44 in Pennsylvania.

GYPSY MOTH WORK BY THE CIVILIAN CONSERVATION CORPS IN NEW ENGLAND

The Bureau continued to supervise the gypsy moth work of the C. C. C. personnel in Vermont, Massachusetts, and Connecticut, this work being done in the area east of the barrier zone and west of the Connecticut River. The working force decreased greatly throughout the year owing to low enrollment and the abandonment of camps. This situation required numerous revisions of work plans and coordination of the work of remaining crews.

During the first part of the year a daily average of approximately 300 enrollees were used from 8 camps—3 in Massachusetts, 3 in Con-

necticut, and 2 in Vermont. Towards the end of the year the daily average of enrollees on this project was only 80, and these were located in 1 camp in Massachusetts and in 3 in Connecticut. The most severe loss to the project was the abandonment of the Westfield, Mass., camp, the entire work program of which was for the gypsy moth project. The loss of the Chester, Mass., camp, where 40 enrollees were available, was also a serious curtailment, since the location of this camp was most favorable for reaching areas of strategic value for protecting the barrier zone.

The work done by the C. C. C. men consisted in scouting, creosoting, spraying, burlaping, and thinning woodland to reduce the growth that is most favored by the insect. This resulted in the silvicultural treatment of about twice as many acres as during the previous year.

The 6-hour man-days used on the work were reduced from 70,630 available for the previous year to slightly over 56,500. Work was done in 58 infestations in 8 towns in Vermont, 126 infestations in 13 towns in Massachusetts, and 68 infestations in 14 towns in Connecticut. The work performed is shown in table 5.

Spraying was done by 3 camps in Connecticut and 1 in Massachusetts. The Bureau furnished 3 machines and 1 was furnished by the Department of Entomology of the State of Connecticut. The State of Connecticut also supplied some of the lead arsenate and some of the labor in that State. The C. C. C. supplied most of the lead arsenate, all the fish oil, and the enrollees and foremen. The work had to be done on a single-shift basis since the camp enrollments were low. In Massachusetts 3 infestations covering 177 acres and in Connecticut 4 infestations covering 582 acres, making a total of 759 acres of woodland, were sprayed.

During the summers of 1938 and 1939 severe defoliation by the gypsy moth of its favored host trees occurred over an area of approximately 4,000 acres east of the barrier zone in Connecticut. Examination of this area during the summer of 1941 showed heavy mortality of trees in scattered locations. Numerous trees died in 1940, and many which produced leaves during the spring of 1941 have succumbed. Many trees that are still alive are in very poor condition and dying. Similar conditions are present on Cape Cod and in areas north and south of Boston, Mass. Large areas in the Lake Winnipesaukee region of New Hampshire and in the Sebago Lake section of Maine have also suffered severely.

The year's work shows a reduction of infestation as compared with last year between the Connecticut River and the barrier zone in Massachusetts and Connecticut. In fact, there has been a very great reduction of infestation in this section during the last 2 years. There are still heavy infestations in several towns in the vicinity of Bellows Falls, Vt., and although considerable defoliation occurred in that section during the summer of 1941 it was not so extensive as during the previous year.

Eight years of C. C. C. gypsy moth work under the supervision of this Bureau east of the barrier zone were completed on June 30, 1941. The greatest number of enrollees on the project at any one time was approximately 2,300. They were assigned from 50 camps located in western New Hampshire and in towns of the Connecticut

424011—42——3

River Valley of Vermont, Massachusetts, and Connecticut, mostly west of the river in the last 2 States. The peak of operation was in December 1935, but it was not maintained owing to a large reduction in the Corps. Approximately 1,126,000 6-hour man-days were used on the project during the 8 years, which, on the basis of 240 working days each year, makes a daily average of approximately 586 enrollees distributed from northern Vermont to Long Island Sound.

As the gypsy moth work of the Corps continued, much information pertaining to the locations of infestations became available, and the woodland thinning was increased in order to reduce the percentage of trees the foliage of which is preferred by the gypsy moth larvae, and to leave stands less favorable for increase of the pest.

During the last three spraying seasons slightly over 5,000 acres of seriously infested woodland in Massachusetts and Connecticut were sprayed in cooperation with the Bureau and State officials.

Over 3,607,000 acres of woodland just east of the barrier zone were examined. Insofar as possible with available help, control treatments were applied where infestations were found. Nearly 6,000,000 isolated trees were examined, 35,000 of which were removed. Thinning was done on approximately 23,000 acres. Over 25,160,000 gypsy moth egg clusters were destroyed, and men in charge of the burlap bands crushed approximately 48,500,000 gypsy moth larvae and pupae.

In addition to the benefits derived from this great volume of work, numerous State and Federal officials and the supervisory force of many camps obtained a better understanding of the problem. Demonstrations of the treatment of woodlands to make them more resistant to the gypsy moth were made for many property owners. Slightly over 11,000 enrollees worked on this project.

Table 5 gives a summary of scouting and control work done by the Bureau and cooperating agencies west of the Connecticut River.

BROWN-TAIL MOTH

Up to the close of the fiscal year 1941 defoliation by the brown-tail moth occurred in many orchards and on residential property in Maine and southern New Hampshire. In fact, this was more general than usual. Work by these States and Massachusetts during the previous winter apparently did not result in the destruction of as many webs as during the winter of 1939–40. For these 3 States 1,215,681 webs were cut and destroyed during the winter of 1940–41, which was about a million webs less than were destroyed during the previous year. Apparently the brown-tail moth is increasing rapidly in these States at the present time.

GYPSY AND BROWN-TAIL MOTH QUARANTINE ENFORCEMENT

CERTIFICATION OF QUARANTINED PRODUCTS

Prompt inspection of tremendous quantities of lumber cut from logs placed in water storage following the destructive hurricane of September 1938 was the most significant accomplishment of the gypsy moth quarantine inspection service. During the year inspectors removed and destroyed 4,733 egg clusters, 678 larvae, and 615 pupae from 111,287 shipments of products inspected and certified

TABLE 5.—*Gypsy moth control work west of the Connecticut River, fiscal year 1941*

State	Project	Scouting							Thinning		Fencing		Banding			Spraying		
		Open country scouted					Woodland	Egg clusters creosoted	Woodland thinned	Trees cut in open	Erected	Removed	Burlap bands applied	Pupae crushed	Larvae crushed	Woodland sprayed	Residential properties sprayed	Trees in open sprayed
		Open areas	Roads	Apple trees	Oak trees	Shade trees												
		Acres	*Miles*	*Number*	*Number*	*Number*	*Acres*	*Number*	*Acres*	*Number*	*Feet*	*Feet*	*Number*	*Number*	*Number*	*Acres*	*Number*	*Number*
Vermont	W. P. A. and regular	60,079	316	87,441	13,192	187,613	81,811	1,427	3	6	33,300	26,327	14,243	304	937	[1] 427	0	0
	C. C. C.	3,100	33	4,980	292	7,680	15,003	200,706	1,003	650	0	0	0	8,475	121,067	0	0	0
Massachusetts	W. P. A. and regular	68,336	650	83,927	7,396	174,814	115,582	26,489	443	2,848	16,532	240,167	59,021	200,568	6,186	[1] 772	0	0
	C. C. C.	3,979	56	7,929	2,126	4,647	24,752	61,013	1,520	1,786	0	38,200	66,345	3,692	84,504	177	0	20
Connecticut	W. P. A. and regular [2]	45,837	406	52,542	25,320	126,016	47,174	3,760	77	538	27,156	200,111	207,875	4,255	9,083	[1] 505	0	0
	C. C. C.	4,611	42	10,627	3,406	25,459	14,772	2,555	1,065	97	4,000	43,500	95,521	2,928	47,928	582	0	0
New York	W. P. A.	52,687	607	71,974	45,143	486,615	57,156	966	164	0	27,200	38,560	8,375	390	259	297	0	0
	State and C. C. C.	350,412	2,460	720,776	0	4,206,293	234,288	8,950	362	0	0	0	[3] 118,015	2	3,020	1,198	0	0
Pennsylvania	W. P. A. and regular [4]	33,202	391	108,563	53,303	557,502	104,766	149,229	257	0	43,532	86,599	277,991	28,162	229,960	3,863	2,025	63,003
Total	W. P. A. and regular [5]	610,553	4,830	1,125,223	144,354	5,738,853	640,777	190,821	1,306	3,392	147,720	591,764	685,520	233,681	249,445	7,062	2,025	63,003
	C. C. C. [6]	11,690	131	23,536	5,824	37,786	54,527	264,274	3,588	2,533	4,000	81,700	161,866	15,095	253,499	759	0	20
Grand total		622,243	4,961	1,148,759	150,178	5,776,639	695,304	455,095	4,894	5,925	151,720	673,464	847,386	248,776	502,944	7,821	2,025	63,023

[1] Includes acrcage sprayed by autogiro.
[2] Includes work performed by State of Connecticut crews in barrier zone.
[3] A small percentage of the bands applied in New York were of sticky material instead of burlap.
[4] Includes work performed by National Youth Administration and Department of Public Assistance workers.
[5] Includes State and C. C. C. work in New York.
[6] Not including C. C. C. in New York.

prior to removal to noninfested territory. There was an increase of approximately 13 percent in the volume of inspection work as compared with the preceding year.

Shipments of lumber from New England have shown consistent increases for the last 2 fiscal years. Prior to 1940, lumber inspection and certification ranged from 23 million to 45 million board feet annually. With the increased demand for lumber for construction of barracks and other buildings at Army camps and for housing projects for defense workers, inspection in the fiscal year 1940 reached 61 million board feet. Demands for lumber inspection this year have exceeded all previous years, with a grand total of nearly 138 million board feet inspected and certified for transportation to points outside the regulated area. In all, 38,290 shipments of forest products were inspected and certified. From these shipments 4,059 egg masses, 567 larvae, and 558 pupae of the gypsy moth were removed. Individual items certified in these shipments were as follows:

Barrel parts, crates, crating	cases, bundles	45,051
Logs, piles, posts, poles, ship knees, and ties	pieces	498,610
Fuel wood	cords	7,211
Pulpwood	do	50,334
Miscellaneous wood	do	3,344
Lumber	board feet	137,839,647
Lags	bundles	16,044
Empty cable reels	number	59,814
Shavings	bales	164,020
Shrub and vine cuttings	boxes	8,652
Miscellaneous	pieces	292,121
Do	carloads	151
Do	bags, bales, boxes	39,908
Do	bundles	558
Do	truckloads	25
Do	tons	1,079

Of the lumber listed above, 6,446,854 board feet originated in the nonregulated area in Maine and were certified for movement into Canada because of Canadian regulations.

Among the heavily infested products inspected were 2 carloads of lumber examined at Concord and Derry, N. H., for shipment to Camden, N. J., and Caraquet, New Brunswick, Canada, respectively. One hundred and fourteen egg masses were removed from each of these shipments. Eighty-eight egg clusters were taken from a carload of birch logs inspected at Conway, N. H., prior to transportation of the logs to Philadelphia, Pa. Numerous other individual shipments yielded quantities of egg clusters when examined prior to certification.

Further complicating this inspection demand was a continued heavy infestation of the moth in scattered sections of the generally infested area. In sections where light infestation in previous years had permitted a less rigid inspection, closer examination of products submitted for certification was required.

Heavier sales by nurseries and greenhouses resulted in a stepping up in the inspection of all items of plant stock. There was a 30-percent increase in most of the types of evergreen and deciduous nursery stock inspected. Twenty-one temporary inspectors were employed in connection with the inspection of nursery products

during April. Ninety-seven egg clusters were removed from 31,574 consignments of nursery stock certified during the year. Products of this type inspected were as follows:

	Number
Shrubs	4,147,278
Specimen trees	46,047
Young trees	523,863
Specimen evergreens	503,903
Young evergreens	4,030,831
Seedlings, cuttings, and small plants	3,074,041

Increased infestation in the lightly infested area, from which Christmas trees may be shipped, required a closer examination of the trees certified during November and December. This increased inspection activity and closer scrutiny of Christmas greenery and trees examined necessitated an increase in the inspection force. The temporary force was increased to 23 in October and to 29 in November, with a corresponding reduction at the conclusion of this seasonal inspection in December. Seven egg clusters were removed from Christmas trees certified. This included 1 egg mass taken from a spruce Christmas tree presented for inspection at Reading, Vt. This was the first egg cluster that had ever been found on a native spruce Christmas tree presented for inspection in the lightly infested area of Vermont. From 19,194 lots of evergreen products examined, 546 egg clusters, 5 larvae, and 30 pupae were removed. Products in this category certified during the year were as follows:

Boughs, balsam twigs, and mixed greens	boxes or bales	54,717
Christmas trees	number	409,897
Laurel	boxes or bales	9,413
Miscellaneous	boxes or bags	13,453
Do	yards of roping	2,000
Do	truckloads	20

There was a considerable increase in the demand for the inspection of stone products, particularly of feldspar. Requests for certain minerals used in the national defense program have resulted in renewed interest in feldspar, mica, beryl, and other minerals found in sections of New England. Many old abandoned mines were investigated and their products sampled. District inspectors were called upon to inspect and certify these shipments.

Stone and quarry products included in 22,229 lots examined during the year disclosed 31 egg clusters, 106 larvae, and 27 pupae. The contents of the shipments were as shown in the following list:

Crushed rock	tons	281,293
Curbing	running feet	5,528
Feldspar	tons	2,120
Granite	pieces	109,517
Do	tons	15,135
Monumental stone	pieces	19,529
Grout	tons	456
Limestone	do	30
Marble	pieces	286
Paving blocks	number	51,701
Miscellaneous	pieces	2,341
Do	tons	2,994
Do	crates, boxes	22
Do	pounds	800
Do	carloads	1

During the year investigations were made of 734 apparent violations of the gypsy and brown-tail moth quarantine.

Rules and regulations governing the movement of quarantined products continued as last revised on September 29, 1938.

DUTCH ELM DISEASE ERADICATION

GENERAL STATUS

For the second consecutive year there was a noteworthy decrease in the number of elm trees found to be infected with *Ceratostomella ulmi*, the fungus causing the Dutch elm disease. Forty-eight percent fewer confirmations were reported this year than in the preceding report. Coincident with this decrease, three new detached zones of infection were discovered, and there was a moderate increase in the main disease area. The general situation is that of a decidedly sparser but more widely scattered infection than in the immediate past. Because of reduced funds it was necessary to concentrate the intensive scouting in representative sections of the main area, and to do less intensive scouting in the remainder of the zone. Comparative results of the two types of scouting indicate that the less intensive work was effective in detecting the great majority of infected trees in any area and that no substantial number was overlooked. This effectiveness was also confirmed by crews engaged in systematic scouting for beetle-infested elms in the same area during the fall, winter, and spring.

Localized infections in the vicinity of Binghamton, N. Y., and Wilkes-Barre, Pa., were largely responsible for an increase in the number of cases discovered in detached areas. Intensive elm-sanitation operations in these infection centers have destroyed trees in which enormous numbers of elm bark beetles, vectors of the disease, were hibernating.

Enforcement of the quarantine prohibiting the movement of elm material from the infected territory continued during the year. A public hearing was held in Washington, D. C., on April 9 to consider extending the regulated area to include infected territory in Pennsylvania. Revised quarantine regulations were pending at the end of the year.

SCOUTING FOR DISEASED OR BEETLE-INFESTED ELMS

Suspect scouting began on June 17, 1940, and was discontinued in the entire work area on September 28. During the summer scouting season 15,746 square miles were scouted on the first suspect survey and 13,230 on the second, a total of 28,976 square miles. These figures represent an increase of 3,518 square miles over last year's coverage on all surveys in the States of Connecticut, New Jersey, New York, and Pennsylvania. A large part of the infected area in New York had to be removed from the 1940 objective for the first suspect survey because the W. P. A. did not approve a classification for scouts. Although the objective of 3,165 square miles in New York was almost completed, only about half of the entire disease and border-zone area was scouted for diseased trees.

No scout schools were conducted this year; hence the full time of the scouts was used in actual scouting work. This was possible

because of the availability of 850 W. P. A. scouts who were trained last year and 450 of the highest ranking per-diem scouts who had had previous training. In addition other trained scouts were employed on regular funds this year for duty in the major work area. The total force assigned to scouting during the months of June, July, and August averaged about 1,300 men, a decrease of 60 percent as compared with the same months in 1939.

Scouting within the known infected area, which was rather intensively scouted during the summer of 1939, was this year handled mostly by automobile and automobile-foot types of scouting. However, 65 areas selected on the basis of last year's infections and widely scattered throughout Connecticut, New Jersey, New York, and Pennsylvania, were intensively scouted this year. In these areas there was a 60-percent reduction in disease this year as compared with the preceding year, and there was a 48-percent reduction over the entire infected area.

Discovery of additional trees infected with the Dutch elm disease in the vicinity of Binghamton, Broome County, N. Y., extended that area to the north, east, and south. Townships involved in this infection cover about 325 square miles, including the eastern half of Broome County and the northeastern corner of adjoining Chenango County.

Discovery by advance scouting crews of 4 disease cases in the city of Wilkes-Barre, Luzerne County, Pa., on August 17 was followed by intensive scouting there during the remainder of the foliar season and by special postseason sampling operations in the city and surrounding territory. Elms in the heavily infected center had been weakened by a new dike along the river. Although the center of infection was found to be within the city, scattered cases were discovered in the city of Kingston, across the Susquehanna River from Wilkes-Barre, and in a number of surrounding townships. Late in September first-record infections were reported from the townships of Jackson and Lanesboro, in Susquehanna County, Pa. The area infected in Susquehanna County is a southern extension of the Broome County, N. Y., area. Total confirmations of infection in these 2 sections at the end of the year numbered 114 in the Wilkes-Barre district and 4 in the Susquehanna area.

Improvement of the disease situation in New Jersey is illustrated by the fact that during the week ending September 7, for the first time since 1935, the number of trees in the State confirmed as infected was less than the number confirmed in either Connecticut or New York.

During the year beetle-material scouting was carried on throughout the entire work area. A total of 144,371 trees were tagged as either infested with the elm bark beetle vectors of the disease fungus or as potentially subject to beetle attack. Of these, 8,169 were in Connecticut, 27,001 in New Jersey, 48,460 in New York, 14,573 in Pennsylvania, and 46,168 in the detached areas.

This nonfoliar-season scouting was begun in New Jersey on October 1. It was so planned that it would progress from the outside of the area toward the center. The border zone was worked first, the outer disease zone next, and the inner disease area last. Beetle material found was generally less than was found last year. The

percentage of infested elms showed an increase, especially in the northern half of the State.

Scouting for beetle material was concluded in the Athens, Ohio, area on January 20, 1941. The scouting area extended for approximately 2 miles around each of the areas infected in 1940, with further extensions in several directions where the continuity of elms or beetle conditions warranted going beyond the 2-mile boundary. A problem that hampered operations in the Athens area was the constant girdling of elms by owners of properties on which the crews operated. In localities where the girdled elms had declined until they became subject to beetle attack, the trees were literally alive with larvae and pupae of *Scolytus multistriatus* (Marsh.).

An increase in the population of *Scolytus multistriatus* was noted in the Maryland work area. Adults of this species were also collected in Bedford County, Pa., about 5 miles north of the Maryland State line, in logs that had been cut for pulpwood. This was the first record of the collection of these insects in this county.

During the year 48,187 samples of elm wood suspected of containing the fungus causing the Dutch elm disease were submitted to the laboratory for culturing and determination. The disease fungus was isolated from 4,803 of these. Connecticut had 393 confirmations, New Jersey 2,915, New York 959, and Pennsylvania 258. In addition, there were a total of 278 confirmations in the several detached areas, as follows: Preston, Conn., 1; Indianapolis, Ind., 9; Kiefer, Md, 1; Binghamton, N. Y., 131; Athens, Ohio, 18; and Wilkes-Barre-Susquehanna, Pa., 118. The discoveries at Preston, Kiefer, and the Wilkes-Barre-Susquehanna area were first records in these localities. There was no recurrence of the disease at the other outlying points where infected trees had been destroyed in previous years.

A total of 62,203 elms have been confirmed as infected since the discovery of the disease in the United States in 1930. Segregated as to location, 1,725 were in Connecticut, 48,067 in New Jersey, 11,419 in New York, 520 in Pennsylvania, and 472 in the isolated infected areas. This accumulative total of 472 cases at the outlying points comprises the following: 7 in Old Lyme and 1 in Preston, Conn.; 122 in Indianapolis, Ind.; 2 in Baltimore, 3 in Brunswick, 2 in Cumberland, and 1 in Kiefer, Md.; 141 in the Binghamton area, N. Y.; 30 in the Athens area, 1 in Cincinnati, and 33 in Cleveland, Ohio; 118 in the Wilkes-Barre-Susquehanna area, Pa.; 5 in Norfolk-Portsmouth, Va.; and 6 in Wiley Ford, W. Va. In the previous report, 7 confirmations at Old Lyme and 10 diseased trees in the Binghamton area were included in the State totals for Connecticut and New York, respectively. These 2 sections have been restored to the status of detached areas and their totals segregated from those of the main disease area.

Training of new scouts employed on Departmental funds was observed for the first time in the spring of 1941 on May 17 in Bucks County, Pa. Emergence of adult *Scolytus multistriatus* was first reported during the early part of May, and general wilting of elm foliage was observed the latter part of the same month.

Training of new scouts employed on departmental funds was begun on June 9, 1940, with 50 men. Upon completion of 1 week's

training, 37 of these were assigned to the border zone. In all 243 men were enrolled for training. Of these, 205 completed the training and were assigned to work in Connecticut, New York, and Pennsylvania. W. P. A. scout training began in the various States during the first week in June. A thorough mental and physical adaptability test was used for the new trainees. Elm identification, recognition of disease symptoms, and climbing were allotted the major portion of the training schedule.

Pending an allotment of emergency relief funds, the employment of the entire W. P. A. personnel was terminated at the end of the year. Field activities during the absence of the security-wage workers were continued by per-diem scouts and appointed personnel. Dismissal of W. P. A. scouts under the law which automatically terminates the employment of security-wage workers who have been continuously employed for 18 months, plus the loss of many men to defense industries and military service, made it necessary continually to request new assignments.

EXTENSIONS OF WORK AREA

As a result of the discovery of diseased elms in or beyond the border-zone scouting area surrounding the known infected area, additions to the infected zone were made which included 91 townships, towns, boroughs, and cities in Connecticut, Indiana, Maryland, New Jersey, New York, Ohio, and Pennsylvania.

Extension of the quarantined zone to include all newly infected points in the major work area added 546 square miles in Connecticut, 427 in New Jersey, 648 in New York, and 217 in Pennsylvania to the regulated area, which, at the end of June, comprised 1,494 square miles in Connecticut, 3,876 in New Jersey, 4,290 in New York, and 977 in Pennsylvania, a total of 10,637 square miles.

ERADICATION AND SANITATION ACTIVITIES

Sanitation work was directed to the removal of trees infested or likely to become infested with the bark beetle carriers of the Dutch elm disease fungus; trees which, while not known to be diseased, contained symptoms that created a definite scouting problem; and, finally, trees dead or dying from some unknown cause which might be the Dutch elm disease but which had not given positive cultures. In these sanitation operations during the year field workers eradicated and removed 4,691 elms confirmed as infected, 151,196 elms in the sanitation program, and 15,415 elms in selective operations, a total of 171,302. An additional 52,738 elms were pruned. Since the start of the eradication program approximately 4,500,000 elms have been removed by sanitation crews. Beetle-infested material has been pruned from 297,000 elms, and over 1,250,000 elms have been removed from certain areas in selective operations designed to simplify scouting and at the same time favor the remaining tree growth.

An ice storm on January 16 and 17 threatened extensive damage to elms in the work area. The low velocity of the wind during the 2-day storm and the rising temperature that immediately followed prevented a repetition of such widespread damage to elms in large sections of the work zone as was experienced on March 3, 1940.

A survey indicated some breakage, but not severe enough to make it necessary to deviate to any great extent from the regular work program.

A large percentage of the selective work, especially pruning, involved the removal of beetle material caused by the heavy ice storm in March 1940. Some of the work in Connecticut was still associated with the severe hurricane of September 1938. Considerable of the remainder of the work was occasioned by beaver dams or road-building operations. After an area is rid of dead and dying elms, the development of beetle material would be almost negligible were it not for such happenings. Inasmuch as the extent, intensity, and time of such damage could not be anticipated, it was frequently necessary to make drastic revisions in work plans and to introduce into the field work as much flexibility as possible.

SOURCES OF FUNDS

Funds for the operation of the project were obtained from a regular Departmental appropriation of $400,000, supplemented by allotments made by the W. P. A. totaling $1,668,874 for field operations and $49,576 for administrative expenses. Appropriations and allotments made by States engaged in cooperative eradications and control work amounted to $4,900 in Connecticut, $3,200 in Indiana, $500 in Maryland, $5,000 in Massachusetts, $41,430 in New Jersey, $118,547 in New York, and $1,500 in Rhode Island.

WHITE PINE BLISTER RUST CONTROL

NEW LEGISLATION

A forward step in the control of white pine blister rust was taken by Congress in April 1940, when it passed the Lea Act (54 Stat. 168–169) for forest protection against this disease. This act prescribed principles, limitations, and procedures for the carrying out of blister rust control activities by the cooperating agencies. It is designed to promote the stability of employment and investments in the industries using white pine through a continuous supply of white pine and sugar pine timber, to coordinate the work of the different Federal agencies having jurisdiction over public white pine forest lands, and to provide a basis for Federal cooperation in control of the rust on lands in State and private ownership.

The Lea Act authorizes the Secretary of Agriculture to use such funds as may be available for blister rust control on all forest lands "irrespective of the ownership thereof." It thus provides for the first time for the use of regular blister rust control appropriations on State and private lands, under the proviso, however, that except where such lands are intermingled with Federal forests, sums equal to such expenditures must be appropriated or contributed by State and local cooperating agencies and individuals.

On the basis of this legislation it is planned that blister rust control appropriations for this Bureau and the Forest Service in the Department of Agriculture, as well as for the National Park Service, the General Land Office, and the Office of Indian Affairs in the Department

of the Interior, will hereafter be combined in one appropriation item in the Agricultural Appropriation Act. This new procedure is being adopted for the first time for the fiscal year 1942.

The work program will be continued under the plan of organization followed in previous years under which the Bureau of Entomology and Plant Quarantine is responsible for the over-all planning, coordination, technical advice, pine-disease surveys, enforcement of the blister rust quarantine, and cooperative work on State and privately owned lands. The Forest Service of the Department of Agriculture is responsible for control work carried out on lands under its jurisdiction, and the Department of the Interior for operations on lands under its administration, including the national parks, Indian reservations, and Oregon and California revested lands.

PROGRESS IN RIBES ERADICATION IN 1940

Blister rust control was carried on during the calendar year 1940 in cooperation with numerous public and private agencies in 27 States. Practical and effective control of the disease is obtained by the removal of currant and gooseberry plants, together commonly called ribes, within infecting distance of white pine.

During the calendar year 1940 the Bureau and the agencies with which it was cooperating destroyed 69,220,205 ribes plants on 1,971,494 acres of control area. The total acreage covered consisted of 1,208,830 acres of initial eradication and 762,664 acres of reeradication. The details of this work by regions are shown in table 6.

TABLE 6.—*Ribes eradication during the calendar year 1940* [1]

Regions	Initial eradication area	Reeradication area	Total initial eradication and reeradication areas	Effective labor	Ribes plants destroyed
	Acres	*Acres*	*Acres*	*Man-days*	*Number*
Northeastern States	336,364	365,474	701,838	139,239	10,983,619
Southern Appalachian States	563,636	92,185	655,821	28,663	3,106,985
North Central States	221,726	117,783	339,509	68,889	16,592,751
Western white pine States (Idaho, Montana, Washington)	36,608	80,990	117,598	144,149	19,834,139
Sugar pine States (California and Oregon)	50,496	106,232	156,728	142,279	18,702,711
Rocky Mountain States (Colorado and Wyoming)					
Total	1,208,830	762,664	1,971,494	523,219	69,220,205

[1] Includes work of cooperating Federal, State, and local agencies.

In recent years most of the ribes-eradication work has been performed with C. C. C. and emergency relief labor, and this policy was continued during 1940. The number of individuals employed during the season totaled 13,249, which is somewhat less than during 1939. Of this number, 5,353 were obtained from emergency relief rolls, 5,293 from the C. C. C., and 2,603 were employees of the Department and its cooperating State and local agencies. The latter include 705 employees used to supervise the large amount of labor employed on this project. Cooperating States and townships provided substantial funds and services for paritcipation in the control program.

Control work in forested areas of the western white pine and sugar pine regions and of northern Minnesota are so remote from sources of labor that it is necessary to subsist the employees in camps. A total of 79 camps were operated during the season, of which 38 were manned with relief labor and 41 with temporary employees of the Department and cooperating agencies. In addition, varying amounts of labor were assigned from 196 C. C. C. camps in the white pine regions of the country. These camps were operated by the Forest Service, Soil Conservation Service, National Park Service, Office of Indian Affairs, and the cooperating States.

The initial eradication of ribes is effective in protecting the white pine from commercial damage for several years, the length of time depending on the original abundance of these plants. The initial working removes all the larger bushes that can be readily found. This establishes control of the disease, and the small missed bushes, seedlings, and sprouts from broken parts of crowns or roots that survive shade conditions and competition with other plants will have become large enough to be readily found by the time reworking is needed. The initial working is often sufficient to protect the pine crop to maturity on areas where ribes plants are not abundant, but where they occur in large numbers on favorable sites it may be necessary to rework portions of the control area two or more times to protect the pine adequately. Control practice takes advantage of the effect of shade and competition with other plants in the elimination of the smaller ribes and by periodic inspection of worked areas determines those portions that need reworking. The reworking is timed so as to remove the bushes before they become old and large enough to produce seed. This procedure results in continued suppression and ultimate elimination of ribes in control areas.

RELATION OF BLISTER RUST CONTROL TO NATIONAL DEFENSE

The conservation of the country's white pine resources is an integral part of the national defense program, as productive forests and timber supplies are recognized to be important military assets in times of war and peace. The white pine wood is light, strong, durable, easy to work, and widely used for many specialty purposes. White pine forests are the primary source of wood for making patterns used in casting metals in the production of military equipment. No adequate substitute has been found for this purpose. The wood of these trees is extensively used for general construction purposes, for the crating of ordnance, and for boxes for packing quartermasters' supplies. There is also a possibility of its being used to a considerable extent as a substitute for spruce in the construction of the thousands of airplanes needed for training pilots.

The commercially important white pines are eastern white pine, western white pine, and sugar pine. These trees have an estimated stumpage value of over 300 million dollars and constitute an important timber resource of great value to the national defense and public welfare. In many local areas the white pine forests are suffering severe damage from the attack of the blister rust fungus. Control of this disease by the eradication of currant and gooseberry bushes is practicable and effective, but these measures are not being applied rapidly enough to prevent all white pine losses.

ACCUMULATIVE RESULTS OF RIBES ERADICATION

Table 7 summarizes by regions the results of ribes-eradication work by all the cooperating agencies through 1940.

TABLE 7.—*Summary of ribes eradication, by regions, from 1918 to Dec. 31, 1940*

Region	Control areas initially protected [1]	Control areas reworked subsequent to initial protection	Ribes plants destroyed	Effective labor
	Acres	*Acres*	*Number*	*Man-days*
Northeastern States	10,819,062	4,108,471	273,026,659	2,621,599
Southern Appalachian States	4,871,783	1,911,930	28,928,960	258,329
North Central States	2,892,192	389,456	221,222,877	883,687
Western white pine States (Idaho, Montana, and Washington)	1,863,302	356,609	415,261,913	1,865,199
Sugar pine States (California and Oregon)	828,098	296,235	141,553,754	690,087
Rocky Mountain States [2] (Colorado and Wyoming)	36,619	1,962	1,583,306	13,896
Total	21,311,056	7,064,663	1,081,577,469	6,332,797

[1] The figures shown are net totals to Dec. 31, 1940, and do not include worked areas that were later removed from control-area status, owing to readjustments of control-area boundaries or to the reversion of certain stands to nonpine-producing types as a result of fire, cutting, or other causes.

[2] The work in Colorado and Wyoming represents experimental ribes eradication in stands of limber, whitebark, and bristlecone pines on national forests to develop practical control measures for the Rocky Mountain region in advance of the spread of the rust. The acreages shown for these 2 States are not at present considered as part of the commercial white pine areas of the United States. No work was carried on in these States during 1940.

As shown in table 7, control has been established by the initial eradication of ribes on 21,311,056 acres. This includes white pine areas and protective zones around pine stands found upon examination to be naturally free of ribes. In addition, 7,064,663 acres have been reworked 1 or more times to maintain control of the disease. This work has resulted in the removal of over 1 billion ribes plants from white pine forests and provided over 6 million man-days of employment. A large proportion of this employment represents the effective use of relief labor in the protection and conservation of a valuable forest resource. There is a total white pine control area of about 30 million acres in the United States, and on over two-thirds of it ribes has been initially eradicated.

LOCATING AND MAPPING OF WHITE PINE

Only white pine stands sufficiently well stocked to have existing or potential crop values are selected for protection. Surveys of forest areas are made to locate and map such stands prior to ribes eradication. Such stands and their protective borders aggregating 1,683,979 acres were mapped in 1940 and scheduled for blister rust protection. These maps are of great value to the field force in quickly locating the areas to be worked and in determining the best procedure and methods to be followed in removing the ribes. Most of the mapping work has been completed in the Western States, but some still remains to be done in the eastern white pine region. Good progress is being made with this phase of the work and it is gradually nearing completion.

NURSERY SANITATION

Control work around nurseries producing white pines for reforestation purposes required the initial eradication or reworking of 21,969

acres of protective zone and the eradication of 225,307 wild and cultivated ribes plants. This work was carried on around 54 nurseries to protect over 58 million white pines growing in nursery and transplant beds. These trees are used so extensively that a supply of uninfected nursery stock is essential for forest and ornamental planting. During the year some diseased pines were found in 2 of the nurseries. These trees were destroyed, and steps were taken to find and eliminate the source of the infection. The annual reworking of the protective zones around several nurseries has practically eliminated the ribes, and where this condition has been reached, further work is reduced to an occasional inspection to make sure ribes are not reestablishing themselves within the control areas.

ERADICATION OF CULTIVATED BLACK CURRANT

The eradication of the introduced cultivated black currant (*Ribes nigrum*) was continued in white pine regions. This plant is so susceptible to the disease that its elimination in white pine regions is a necessary step in the control of white pine blister rust. During 1940, 7,091 of these plants were destroyed in 1,052 locations. Nearly all these bushes were removed in the Lake States region. This phase of the control program has been largely completed in the principal white pine regions of the country. A small number of these plants will probably be found by the eradication crews each year for a considerable period of time. This is due to old bushes missed in the first survey and to a limited number of new bushes planted by families moving into control areas who are not familiar with local regulations concerning the planting and possession of cultivated black currants. Since the beginning of control operations 547,356 of these plants have been eradicated, and this work has removed one of the principal sources of damage to the pines. The remaining cultivated black currants are capable of serious local damage to pine, but now they are so few and scattered that they no longer constitute a major factor in the spread and establishment of the rust.

SPREAD OF BLISTER RUST IN 1940

In the southern Appalachian region blister rust was found for the first time on ribes in Mineral, Grant, Hampshire, Morgan, and Berkeley Counties, W. Va., and at two locations about 15 miles apart in Clarke County, Va. Scouting in West Virginia indicated a light ribes infection over the area as a whole. Additional pine infection centers were found in Virginia in Page, Rockingham, Highland, and Augusta Counties. Blister rust was found for the first time on white pine in Hampshire County, W. Va. Scouting for the rust in the southeastern counties of Maryland gave negative results.

In the North Central States the rust was found on ribes for the first time in Jackson and Ingham Counties, Mich., Todd and Olmsted Counties, Minn., and Black Hawk County, Iowa. On white pine it was found for the first time in Iowa County, Wis., Goodhue County, Minn., and Alger, Jackson, Presque Isle, and Charlevoix Counties, Mich. Rust on either pine or ribes, or on both, has been found in all Wisconsin counties, in all but four Michigan counties, in the northern and eastern portions of Minnesota, in northeastern Iowa,

and in the northern half of Ohio. In Illinois and Indiana ribes infection has been found in northern counties, but no infected pines have been reported. No new counties in Illinois, Indiana, or Ohio were added to the infected list in 1940.

In the western white pine region of eastern Washington, northern Idaho, and western Montana the known infected area remained unchanged. With pine infection scattered over all the white pine belt of the Northwest, infection may be found on ribes each year in all parts of this area where these bushes occur in any number. Consequently the rust infection is spreading at a greatly increased rate in those unprotected drainages where the disease has been present for several years, particularly in the younger stands.

In California an important development in the spread of the rust was the discovery of two infected sugar pines along Bailey Creek near Viola, Shasta County, on the Lassen National Forest in the general vicinity of ribes infections found there in 1938. This infection places the known southern limits of pine infection in California about 107 miles south of the Oregon border and is the first record of the rust on pine in Shasta County. One small sugar pine was found infected in the Montgomery Creek area, also in Shasta County, where there were numerous infected ribes in 1938.

On the Klamath National Forest the infections were distributed in 14 principal locations falling in 3 general areas, viz, the Indian Creek basin, the Elk Creek basin, and the Klamath River from Happy Camp to Somes Bar. In the 14 centers of infection there were 250 diseased sugar pines having a total of 928 cankers, or an average of 3.7 cankers per tree. The largest infection center numbered 105 trees with 550 cankers. Although the cankers originated largely in 1937, and some had developed pycnia for 2 successive seasons, none had produced aeciospores.

TREATMENT OF INFECTED WHITE PINES

In generally infected regions, in public parks and recreational areas and around homes, there are many white pines that are highly valued for ornamental and esthetic purposes. Many of these are infected with blister rust. If they are not too badly diseased, they can be saved by cutting out the infected parts of the tree and removing all ribes in the vicinity to prevent their reinfection. In the Eastern States 39,757 cankers were removed from 17,673 trees, and 370 fatally infected pines were destroyed. In the western white pine region, 32,069 white pines were salvaged by the removal of the infected parts of the trees, and 8,800 were destroyed because they were so badly diseased that they could not be saved. This work was performed on publicly owned lands in cooperation with the agencies administering those lands. When the infected pines occurred on private property the owners furnished the labor, and cooperation was extended to them in form of technical direction and supervision.

DEVELOPMENT AND IMPROVEMENT OF CONTROL PRACTICES

Ribes bushes are destroyed by hand, chemical, and mechanical methods. Most of the control work is performed by small crews of men, who systematically cover the pine areas, pulling up the bushes by

hand, or uprooting them with the aid of a mattock. In some locations where this method is impracticable the plants are destroyed by spraying them with chemicals. In other local situations the ribes and associated brush are removed by the use of bulldozers. The cleared area is then seeded to forage grasses, thus converting the brush type into permanent meadow or grazing land. Areas treated by the bulldozer method are limited in size and are found only in the white pine and sugar pine areas of the Western States. In order to get effective results, blister rust control work requires careful supervision and expert technical direction by qualified, experienced men who are familiar with the disease and the methods used in its control.

The field tests of dry chemicals in 1939 demonstrated the effectiveness of a mixture of dry borax (technical powder) and common salt (vacuum-refined table or dairy salt) for killing decapitated ribes crowns. This new herbicide is prepared by thoroughly mixing 1 part by weight of each chemical, and is held to be superior to the previously recommended mixture of sodium chlorate and borax because of ease of handling, readily available supply of chemicals, lower cost, and less hazard to wildlife. For these reasons the new mixture should have wider application in all blister rust control regions and especially in national parks. Developments in the use of oils for ribes eradication in California showed that the following two formulas are as effective as straight Diesel oil or more effective: (1) Furfural, technical, 5 percent and Diesel oil 27°–29° B., 95 percent by volume; (2) sulfur dioxide extract from lubricating oils 20 percent and Diesel oil 27°–29° B. 80 percent by volume.

The efficiency of hand-grubbing ribes in dense brush fields was improved by employing a specially equipped D–2 caterpillar tractor to make man-ways across troublesome areas. A winch-operated ribes hook was effectively used in conjunction with the same tractor for uprooting large bushes in more open forest types.

A canvas safety sling and a mechanically operated safety catch were devised for the protection of workers destroying ribes growing in cliffs or in steep, hazardous situations. The equipment was used in Oregon early in the summer of 1940 and was found to be satisfactory. An application has been made for a public service patent on the safety catch.

During 1940, practical control operations made use of the following special methods of ribes eradication: Broadcast spraying with aqueous chlorates, decapitation of troublesome rock-bound ribes followed by the application of dry chlorated-borax or Diesel oil, dynamiting of abnormally large bushes, and power eradication of ribes on special limited sites by means of a tractor equipped with a brush rake and with a special hook operated by a logging winch.

Results of pollination tests on ribes flowers definitely show that wild ribes is rarely, if ever, self-fertile and that cross pollination must occur before such plants can produce mature fruits. This has an important bearing on long-range planning of control work and gives promise that continued eradication of ribes should be aided by this natural phenomenon as these plants become scarce in white pine areas.

CEREAL AND FORAGE INSECT INVESTIGATIONS

INSECTS ATTACKING CORN

Large numbers of corn earworms in hibernation were killed by the severely cold winter of 1939–40 throughout the Northern States. This was clearly indicated by the results of extensive hibernation experiments under cage conditions. As a result of this, early sweet corn in the Eastern States escaped much injury by the corn earworm.

In the breeding of corn for resistance to the corn earworm three selections of dent corn, Yellow Squaw, High Oil, and St. Charles White, were produced which appeared especially promising in the F_3 generation. A partial report of this work was published in the Journal of the American Society of Agronomy during the year. Combined resistance to both the earworm and the chinch bug is being sought in recently initiated corn-breeding experiments. As a result, several lines of corn exhibiting apparent dual resistance have been selected for future experimentation.

Further progress in the protection of sweet corn from attack by the earworm was marked by the issue of Bureau circular E–525, entitled "The Use of Oil or Oil Containing Insecticides for Earworm Control in Sweet Corn." This publication renders available three optional methods of control suitable for application to corn grown for market or home garden purposes.

A 4-year study to determine the northern geographic limits of hibernation for the corn earworm was completed and a manuscript prepared reporting the results of this work. It was found that during dry, mild winters the limits of successful hibernation extended considerably farther north than in cold, damp seasons. Hibernation is much facilitated by the occurrence of sandy, well-drained soils.

The season of 1940 proved favorable to the development and multiplication of the European corn borer. Accordingly the loss to the corn crop as indicated by surveyed comparable areas was 6½ million dollars as compared with 4 million in 1939. Significant increases in abundance occurred in parts of Ohio, Indiana, western and eastern New York, New Jersey, Maryland, Delaware, and Virginia. In Illinois 11 new counties were reported infested and 4 in Virginia, 4 in Wisconsin, and 1 each in Ohio and Maryland.

Although, owing to the cold backward spring of 1940, the corn borer got off to a late start in the Great Lakes Region, an increasing tendency toward the production of two generations annually was observed, particularly in Ohio, where a single generation had previously been the rule.

An annual study of the effects of cultural control in reducing the numbers of the corn borer in a heavily infested area near Waltham, Mass., showed for a second time in succession a high degree of success. An average of 98-percent control was obtained by growers who voluntarily applied cultural and clean-up methods advocated by the Department.

In the examination of the status of the parasitic enemies of the corn borer, 13,000 borers were collected and scrutinized for evidence of parasitization. It was found that 40 percent of the borers were

parasitized in an area known to be favorable for the parasites in eastern Massachusetts. The average rate of parasitization for the whole of New England, however, was 18.5 percent, which has resulted from the introduction of parasites from Europe in former years. More than 30,000 borers were collected to serve as breeding material for parasites next year. A total of 190,783 parasites were liberated in 1940.

Insecticidal methods of control, originated and already announced by this Bureau, have permitted the profitable production of market sweet corn under conditions of severe general infestation of the corn borer. More recent efforts in this direction have been exerted toward the cheapening and improvement of these methods through their more rapid and economical application. A horse-drawn boom sprayer was designed which gave results comparable to those obtained with the much slower hand-operated apparatus. A new mixture of nicotine-peat, having a bentonite carrier, gave excellent control.

In the breeding of strains of corns possessing resistance to the borer 469 hybrid and inbred entries were tested by means of manual infestation to insure known borer densities in each plot. Bantam inbred corns that had previously evinced resistance gave results confirming their material resistance to attack. Hybrid combinations whose pedigrees included two relatively resistant parents showed, on an average, lower levels of borer infestation.

In the study of resistant field corns a total of 297 inbreds were infested manually and tested for resistance to the borer in 1940. Six of these resistant corns averaged 54 percent fewer borers than the average number observed in 6 commercial hybrids not bred for resistance.

GRASSHOPPERS

Flights of migrating grasshoppers were much less extensive in 1940 than in 1939. However, 137 such flights of the lesser migratory grasshopper were observed or reported, mostly in northern Montana and contiguous areas. Of these, 23 occurred in new territory in Montana, but usually these areas were already infested to some extent. The Judith Basin and southeastern Fergus County sustained severe local injury to immature wheat. Records for this area render it only slightly probable that extensive flights might occur here in 1941.

Many valuable data were obtained regarding the species under observation in the areas of permanent, intensive grasshopper study located at 22 strategic points throughout the Rocky Mountain and Great Plains States.

A peculiar phenomenon of grasshopper behavior in 1940 was that the general hatch began in northern Montana and proceeded southward into South Dakota, which is in reverse order of the usual seasonal occurrence.

Although cumulative rainfall is known finally to effect a general decrease in grasshopper abundance, the data thus far obtained in study areas indicate that a combination of several factors is involved in such a resultant. It was also observed that maxima of grasshopper mortality occurred annually during two periods of their development, namely, during the egg stage and at hatching time; in fact, more than 95 percent of the annual mortality was observed to occur at these times. Studies of feeding habits of the range-land-

inhabiting grasshoppers showed that their food plants were about evenly divided between the grasses and plants not of the grass family. The typical short-horned grasshoppers of the subfamily Acridinae strongly preferred the grasses. It also became apparent that about half of these range species of grasshoppers preferred soils of one or two distinct types in which to deposit their eggs.

Some 3,000 examination records of the distribution of range-land grasshoppers made in 11 States in 1940 furnished the basis not only for tables giving distribution of species but also for an excellent map serving to visualize the distribution of 52 species concerned.

In efforts to improve the chemical and physical efficiency of poisoned baits for distribution by airplane, it was found that the bait mixtures under investigation lost about 60 percent of their water content while falling to earth from the airplane. Excellent bait distribution resulted from spreading dry bran-and-oil baits by the use of a power duster. On dry-land areas baits of low water content spread by airplane gave results that compared favorably in effectiveness and cost of application with standard bait applied by means of mechanical spreaders operating on the ground.

MORMON CRICKET

In the biological studies conducted to obtain the fundamental knowledge of the development of the Mormon cricket necessary for efficient control purposes more than 68,000 eggs of the insect were collected from 4 States. Examination showed that of these 67.8 percent were viable, or alive, 8.7 percent were parasitized, and the remainder were sterile. The effects of prevailing temperature and moisture conditions on the development of the embryos within these eggs were revealed in subsequent studies. From these it appears that development was possible at soil temperatures ranging from 60° to 90° F. The most favorable, or optimum, conditions were furnished by a constant temperature of 75° with an accompanying soil-moisture content of 50 percent.

The appearance of large hatches of Mormon crickets at 2-year intervals in the Big Horn Mountains of Wyoming led to studies revealing that in this elevated area a developmental period of 2 years was required for the full life history of the insect.

Necessary expansion of the research work on the Mormon cricket required the opening of a new laboratory as of July 1, 1940, at Winnemucca, Nev.

The development of a series of poisoned baits was begun in 1940 in which a single gallon of cheap lubricating oil was substituted for 15 gallons of water. This substitution proved successful and is regarded as highly important, because water usually is scarce in many remote range areas where Mormon crickets must be combated. Furthermore, the dry oil bait may be mixed far in advance of field needs and transported thereafter at greatly reduced cost as compared with the heavy water-soaked wet bait.

Excellent control was obtained where either this oil bait or wet bait was distributed on more than 7,000 acres of dry land by airplane in Nevada.

A new publication, Circular 575, entitled "Control of the Mormon Cricket by the Use of Poisoned Bait," was issued in October 1940.

WHITE-FRINGED BEETLE

The effect of the unusually cold spring and early part of summer of 1940 was reflected in the behavior of the white-fringed beetle by its emergence from the soil considerably later than in previous years. By July 1, in former years, nearly one-half of the total emergence had occurred, whereas in 1940 only about 3 percent of the beetles had appeared. The subsequent seasonal development of the insect was correspondingly delayed, with the result that adults were still abroad as late as December 30, or more than a month later than in previous years.

From the work of the past year it became increasingly evident that some of the larvae hatched in any given year do not mature as beetles until the following year and require more than a year for their life cycle.

Mortality among the larvae in the field was observed to be heavy, amounting to 71.7 percent between December 2, 1939, and May 2, 1940. It was also shown that 50 percent of such mortality occurred within 1 month after hatching.

White-fringed beetle grubs present in the soil at the rate of 50 per square yard were found to injure peanut plants to the extent of 22 percent.

Owing to the wet summers in the Gulf States, and frequent heavy rains, insecticides applied to plants for the control of the beetle are quickly washed away and thus become ineffective. Many substances have been used experimentally to prevent this, but the best and cheapest found in combination with cryolite was wheat flour, 25 percent by weight. It was found, however, that cryolite applied to peanut plants reduced the yield of nuts by more than 28 percent although no injury to the leaves or stems was apparent.

Experiments conducted with 13 different makes of calcium arsenate, under laboratory conditions, gave consistently better kills of the beetle than did cryolite. A new concentrated spray consisting of casein 1 pound, raw linseed oil 1 pound, triethanolamine 0.15 pound, and calcium arsenate 10 pounds, applied at the rate of 10 pounds per acre, still adhered to the plants after rains amounting to from 2 to 5 inches.

INSECTS ATTACKING FORAGE CROPS AND PASTURES

Investigations of the legume weevil (*Hypera brunneipennis* (Boh.)), an insect very similar in appearance to the alfalfa weevil, are progressing at Yuma, Ariz., where the pest was discovered in 1939. This weevil, apparently native to northern Africa, has habits which are closely adapted to the hot, dry climate of the Southwest. Upon the approach of the hot season it hides away and becomes torpid until late in the fall. The legume weevil became much more numerous in alfalfa in the fall of 1940 than had previously been the case, as many as 33 weevils per square foot having been observed in that crop. Fortunately the heavy infestation in alfalfa observed in the fall did not persist, as only a small proportion of the larvae survived to produce beetles in the spring of 1941. In contrast with this, the survival of the insect was very high on sourclover, a volunteer forage plant of no great value in this region but the general distribution of which may serve importantly to complicate the control of the legume weevil in

more valuable crops. The maximum deposition of eggs by individual captive females of the insect was 906 on alfalfa, 1,542 on sourclover, and 1,784 on Hubam clover. These records of egg deposition for these plants represent an increase of 53, 94, and 119 percent, respectively, over those of last year. They would seem to indicate that alfalfa, the most important forage plant of the region, is the least favorable for the development of the insect.

Feeding tests with 25 different legumes revealed that the legume weevil is capable of subsisting on all or any of them. The insect was reared to the adult stage on berseem, Ladino, and crimson, red, and white Dutch clovers as well as on soybeans.

The extensive and protracted investigations of the alfalfa weevil, centered at Salt Lake City, Utah, were terminated as of June 30, 1940, except for tests to determine dosages and exposures necessary for the effective fumigation of alfalfa hay produced in the infested region. As these data were obtained later in the year, this activity has been concluded and publications containing complete reports of the technical and practical results of the work are being prepared for issue in the near future.

The summer of 1940 marked the triennial appearance in Wisconsin of the brood of May beetles known as brood C. As these beetles produce the white grubs that are excessively injurious to pastures and field crops, studies of the flights of the beetles and their food preferences were made. These beetles fly only at night, and collection of them involves difficulties not encountered with many other insect pests. During the spring and summer period more than 5,000 beetles were picked from their food trees, shrubs, and other plants. This was done in order to record the various food plants of the 13 different species inhabiting that section. During the period May 6 to July 6, 1940, 22 flights of these beetles were observed in southern Wisconsin, where white grubs are injuriously prevalent. The data thus obtained were published in December 1940 in the Annual Report of the Wisconsin Agricultural Experiment Station. More than 7,000 adult May beetles of 58 species and 3 varieties, captured in Japanese beetle traps at 130 Bureau stations in 28 States, were studied for records of distribution.

A study was made of the food-plant preferences of the white grubs in field crops grown in southern Wisconsin. Their choice of plants, as indicated by egg deposition, was as follows and in the order given: Bluegrass, red clover, timothy, alfalfa, oats, Sudan grass, sweetclover, corn, and soybean. The legumes, however, were observed to be unfavorable for the development of the grubs, and it is believed that the lower soil-moisture content prevailing in leguminous crops was responsible for high larval mortality. Further study of the matter is necessary before final conclusions may be drawn. Experiments with poisoned baits for the control of the grubs gave some promise of future utility with grubs in some stages.

INSECTS ATTACKING STORED GRAINS AND CEREALS

Because of the present emergency increased attention was given to the preservation of stored staple grains, including corn, wheat, rice, and processed cereals, from attack by insects. Especial effort was directed toward the protection of corn stored under the provisions

of the ever-normal granary. Surveys financed by the Commodity Credit Corporation, initiated in July 1940, indicated that a portion of the corn stored in Missouri, Illinois, and Iowa was seriously infested, principally by the Indian-meal moth and the various bran bugs. These pests had caused both heating and molding of the grain to some extent, thus reducing its grade. High moisture condition of the grain at time of storage and the presence of a considerable percentage of broken kernels had predisposed the grain to insect attack. This infestation was controlled by fumigation with a mixture of ethylene dichloride and carbon tetrachloride together with the ventilation or turning of the grain. Reinfestation of the corn was prevented by giving its surface a thin coating of light tasteless mineral oil.

As under present conditions some of the grain stored on farms will be used for seed purposes, the question of whether fumigation might injure germination became important. An investigation showed that the ethylene dichloride-carbon tetrachloride mixture, as recommended by the Bureau, was both effective as an insect control and entirely safe as far as germination of the grain was concerned, even in larger dosages than usually recommended.

Many of the other fumigants tried were found to more or less seriously injure germination, depending on the amount of moisture present in the grain. A moisture content of 16 percent or more rendered the corn particularly liable to such injury.

The practicability of using commercially the flash-heat method of sterilizing the grain stream as it enters the mill was conclusively demonstrated. The grain was run successively through metal cylinders heated to 212° to 400° F. for intervals ranging from 10 to 40 seconds. During this brief period it became hot enough to destroy all insect life contained in it, without injury to the grain or to flour subsequently made from it. Tests of commercial grain sterilizers, utilizing steam at pressures of from 70 to 100 pounds per square inch, demonstrated that milled cereals entering such a heater at 68° were discharged in from 5 to 10 minutes at a temperature of 160°, which is quickly fatal to all insect life.

Previous investigations having shown that milled cereals being transported in railroad cars are exposed to infestation by insects concealed in the cars, effort was made to discover means for protection of such cereals. This was apparently found in the practice of lining the cars with a thin, tough paper that had been impregnated with nicotine sulfate solution. Further work with this is required for confirmation of this finding.

Additional evidence was obtained of the value of methyl bromide as a fumigant for grains and cereals under conditions where the gas can be confined to prevent its too rapid escape. It was found that a modern concrete warehouse of 250,000 cubic feet capacity was successfully fumigated with a dosage of 1 pound of methyl bromide per 1,000 cubic feet of space.

As rice is grown under climatic and other environmental conditions that render it peculiarly liable to infestation by insect pests, damage by insects under storage conditions is both general and heavy. The grain is invariably infested to some extent when placed in storage, and contains moisture sufficient to encourage intense activity of the

insects contained in it. Examination of a typical rice warehouse in July 1940 resulted in a collection of rough rice, from floor cracks, under scale platforms, and in similar locations, containing 400 live grain pests per quart. It was estimated that such hiding places in this building gave refuge to at least 100,000 insects ready to serve as breeding stock for the new crop shortly to be put in storage.

Methyl bromide as a fumigant for both rough and clean rice was again shown to be of unusual value where it was possible to apply it under reasonably airtight conditions. For instance, a tight brick warehouse containing 127,500 cubic feet of space and holding at the time 1,269,000 pounds of sacked rough rice was fumigated with entire success with a dosage of 2.29 ounces to each 1,000 pounds of rice.

INSECTS ATTACKING SMALL GRAINS

The work of producing varieties of wheat possessing resistance to the hessian fly has progressed to a point permitting a large-scale test of the Big Club 38, originated through cooperative research. Thirty acres of this wheat planted in Solano County, Calif., in 1940 showed a reduction of 96 percent in hessian fly infestation and an increased yield of 30 percent over adjacent fields of regular club wheat. This resistant variety is a hybrid of Dawson × Big Club 3. Another variety, being the F_3 generation of Poso 5 and Dawson × Big Club 5, tested in 286 rows of the latter strain as compared with 209 rows of the former, demonstrated that the resistance of the Dawson had been transmitted undiminished through all backcrosses to susceptible parents, thus furnishing sufficient agronomically desirable resistant lines to permit completion of the planned breeding program.

Resistant hard red winter wheats are being developed at Manhattan, Kans., where at least 100,000 plants were examined in the breeding operations of the year. Resistance tests were made of varieties and complex hybrids, involving winter wheats with fly-resistant characters transferred from wheats possessing the spring habit. Resistance tests of advanced Marquillo hybrids showed that out of 109 selections 40 percent incurred infestations of less than 10 percent. Large numbers of selections derived from very promising new crosses are being tested for hessian fly resistance. Efforts are being made here to combine in winter wheats qualities of fly resistance with resistance to stem rust and other serious diseases of wheat.

The cold rainy spring of 1940 served to reduce the threat of chinch bug injury materially. Further work with the mineral oil emulsions for use especially on high-value experimental wheats gave such excellent results that they have been published.

Although it became necessary, for financial reasons, to terminate the cutworm research project on June 30, 1940, a severe outbreak of the pale western and army cutworms in the spring of 1941 occasioned damage and grave alarm in northwestern Texas and southwestern Kansas. This outbreak necessitated further attention to the cutworm problem at the expense of other activities. In the vicinity of Amarillo, Tex., 95 percent of the small grains were destroyed, there being more than 4 cutworms per lineal foot of drill row in some areas. A publication containing a summary of known control measures and facts regarding the life history of the pale western cutworm was issued in April 1941.

SUGARCANE INSECTS

The work of entomologists and plant pathologists led, in 1940, to a suspicion that a new and serious disease of sugarcane known as chlorotic streak was being spread through the agency of insects. Research work with a common leafhopper, widely dispersed throughout the Sugarcane Belt, has shown that this insect, closely related to the sharp-nosed grain leafhopper, was a carrier, or vector, of this disease. The insect involved is *Draeculacephala portola* Ball, a species not heretofore recognized as a serious pest of cane. A publication announcing this discovery has been issued. No practical control for this insect is known.

The experimental use of cryolite as an insecticide for the control of the extremely injurious sugarcane borer in Louisiana continued to give most encouraging results both in the plot experiments and on large-acreage experimental areas. In the former, four applications at 7-day intervals gave 99.5-percent control. In a large-acreage experiment under plantation conditions, synthetic cryolite applied four times at a total estimated cost of $3.88 per acre gave 95-percent control. Although this cost seems at first glance to be high, the great increase in cane and sugar production obtained by control of the insect would render this method of control profitable.

The beneficial effects of burning sugarcane trash during fall and winter to destroy its content of borers was shown in a test of burned and unburned fields. In the burned fields it was found that a population of only 9.6 borers per acre survived, while in the unburned fields there remained 144 live borers per acre.

The successful eradication of an infestation of the West Indian sugarcane mite (*Tarsonemus bancrofti* Michael) seemed assured at the Canal Point, Fla., Cane Experiment Station of the Department. This operation was undertaken early in the spring of 1941 through cooperative action of the Bureaus concerned under an allotment from the fund for control of incipient and emergency outbreaks.

WHITE-FRINGED BEETLE CONTROL AND ERADICATION

The white-fringed beetle situation was characterized by a lessening of the intensity of infestation throughout the areas as a whole. Intensive control measures have been continued, supplemented by the enforcement of Federal and State quarantines, and no spread of the pest has been found beyond the vicinity of former infestations existing in limited areas in Alabama, Florida, Louisiana, and Mississippi. There was no general appreciable damage to crops in any area, and crop losses in individual fields were slight.

The program of activities for the spring and summer of 1941 had for its purpose determination of the effect of suppressive measures on selected types of infested areas during the entire period of beetle emergence, with a view to possible eradication of isolated infestations. On other areas on which there was danger of artificial or natural spread of infestation, suppressive measures were provided during the period of peak emergence. In the last quarter of the year almost daily rainfall throughout practically all the infested areas necessitated modifying the control operations to eliminate the

use of insecticidal dusts wherever possible and to substitute sprays to secure better adhesiveness on vegetation.

During the year it was possible to make further modifications in the quarantine regulations by removing all restrictions on many articles and making less drastic the conditions of certification on others. New methods were made available for treatment of nursery stock, shipment of which previously had been restricted to points within the regulated areas. It is believed that approximately 95 percent of the nursery stock produced in the regulated areas is eligible for certification under the quarantine regulations because of having been grown under prescribed sanitation conditions and protected from infestation and because of the application of authorized methods of treatment.

Full cooperation in the year's activities was given by the pest-control officials of the affected States.

MORMON CRICKET CONTROL

The protection of crops from Mormon crickets was continued with Federal funds appropriated for the control of emergency and incipient outbreaks of insect pests and plant diseases, supplemented by State and county assistance in seven Western States. Control activities on Government-owned lands and areas and adjacent thereto were conducted cooperatively with the Indian Service and the Division of Grazing of the Department of the Interior, the Soil Conservation Service and the Forest Service of the Department of Agriculture, and the Civilian Conservation Corps. Mormon cricket infestations east of the Rocky Mountains have been so reduced by control operations that control in these areas during the season of 1941 was largely by farmers' volunteer efforts. West of the Rocky Mountains large populations of crickets still existed and activities were directed toward reducing these large bands.

In the spring of 1941, as indicated by the 1940 fall survey, approximately 9 million acres were infested by Mormon crickets, a reduction of 5 million acres from the report of 1940 and of more than 9 million from 1939.

During the control season of 1941 an estimated 500,000 acres of crops were protected from Mormon crickets. The program was marked by a wide use of sodium fluosilicate bait, which replaced to a great extent the use of sodium arsenite dust. Over 4,200,000 pounds of bait were spread by power machines and by hand on 448,000 acres, and nearly 194,000 pounds of dust were used in power and hand dusting of 37,175 acres. Seven hundred and seventy-one mile-days of metal barrier and 135 mile-days of oil barrier were maintained.

In Idaho, Nevada, and Oregon aircraft was successfully used in baiting operations, 625,480 pounds of bait having been spread over more than 98,000 acres, an average of 1,752 acres per airplane-day.

GRASSHOPPER CONTROL

The survey of adult grasshoppers and their eggs in the fall of 1940 indicated that the infestations would be much lighter in 1941 than in the previous 3 years. It was anticipated that the heaviest occur-

rence of these pests could be expected in Kansas, Minnesota, North Dakota, and South Dakota. Assistance in combating grasshoppers in 1941 was given farmers in 24 States where outbreaks of an emergency nature occurred.

The plan for the control activities was arranged in each State by Bureau and State officials previous to the active control season. Memoranda of understanding indicating the scope of the control work and the responsibility of each organization were prepared and signed for each State. Cooperative grasshopper-control work was also conducted in conjunction with the Indian Service of the Department of the Interior, the Soil Conservation Service and Forest Service of the Department of Agriculture, and the C. C. C. and other Federal agencies.

Early in 1941 Bureau supervisors began careful inspection, reporting early grasshopper hatches and places showing evidence of concentrations of grasshoppers. Arrangements were made for the opening of mixing stations and for the mixing and distributing of bait. The bait materials, bran, sawdust, and sodium arsenite, are furnished from Federal funds appropriated for the control of incipient and emergency outbreaks of insect pests and plant diseases. Local storage, transportation, and mixing of the bait are furnished by the county or other agencies.

Few heavy outbreaks occurred in 1941. In Kansas extensive populations of the lesser migratory grasshopper (*Melanoplus mexicanus* (Sauss.)) occurred in the southwestern counties. Because the grasshoppers there remained in the marginal vegetation and did not invade crops, little baiting was done by farmers. In the middle of July these grasshoppers began migrating, and the main concentrations were disseminated over eastern Colorado and the northwestern counties of Kansas. Very little damage to crops occurred, but these insects may produce a large second generation which will probably attack wheat in the fall. The use of additional large quantities of bait may therefore be expected in Kansas.

Relatively high populations of the lesser migratory grasshopper developed the first week in June on range lands in Cochise and Graham Counties, Ariz., spread over nearly a million acres, and later invaded small cultivated areas. Bait spreaders and ample supplies of bait were furnished farmers whose crops were threatened, but an effort to control the range infestation was deemed impracticable because of the extensive acreage infested and the fact that it was purely range area.

A heavy infestation of the two-striped grasshopper and of other species occurred in northwestern Minnesota, but the use of bait prevented heavy crop losses. Heavy nymphal infestations in eastern North Dakota were materially reduced early in the season by natural control factors. Heavy infestations occurred in parts of South Dakota, Montana, and Nebraska. In Texas there were some infestations of the lesser migratory grasshopper in the Panhandle, and baiting was done in east-central Texas where the differential grasshopper invaded cotton fields in the river lowlands. No extensive flights occurred during the season except those in Kansas. On July 1, 1941, 20,000 tons of wet bait had been spread. The States using the larg-

est quantities were as follows: Montana, 4,600 tons; Minnesota, 4,000 tons; South Dakota, 2,500 tons; Nebraska, 1,650 tons; and Texas, 1,100 tons.

CHINCH BUG CONTROL

The results of the surveys conducted in Illinois, Indiana, Iowa, Kansas, Missouri, Nebraska, Oklahoma, and South Dakota by Federal or State inspectors in the fall of 1940, and of observations by State inspectors throughout the winter, indicated that moderate to heavy infestations of chinch bugs might be expected in 1941 under normal weather conditions. Funds for chinch bug control were therefore allotted in June 1941 from the appropriation for the control of emergency and incipient outbreaks of insect pests and plant diseases. Provision was made for the purchase and delivery of creosote for the construction of barriers to prevent migrations of the immature bugs from small grains into corn. Heavy rains at frequent intervals in June reduced considerably the population of chinch bug nymphs, and the need for protecting the cornfields was minimized. Nearly 286,000 gallons of creosote were purchased, however, and delivered to the infested States—about 12 percent of the quantity provided in the previous year.

LEGUME WEEVIL SURVEY

In the spring of 1941 a survey was made for infestations of the legume weevil (*Hypera brunneipennis* (Boh.)) at Yuma, Ariz., where the weevils were originally found in 1939, and of other areas in Yuma and Maricopa Counties, Ariz., and adjacent sections at Winter Haven, Calif., found infested in the 1940 survey. Several infestations were found to have increased considerably in spread and intensity. No new areas of infestation were found. The Bureau cooperated with the State in efforts to eradicate the incipient, isolated infestation at Tempe, Ariz. Adjacent area in Mexico was also surveyed with the cooperation of the Mexican Government without any weevils being found.

EUROPEAN CORN BORER INSPECTION AND CERTIFICATION

Federal inspection and certification of products that might carry the European corn borer were continued with the personnel necessary to fulfill State requirements prescribing that such host material must bear Federal certification before entry into Arizona, California, Colorado, Georgia, Louisiana, Nevada, Oregon, Texas, and Utah. Inspection services for European corn borer certification were available during the year through the Japanese beetle and gypsy moth inspection corps and by corn borer inspectors stationed in Indiana and Michigan.

A total of 46,074 certificates were issued to cover quarantined plant material valued at $275,000. This represented a 25 percent increase in the number of certificates over the preceding year, with a corresponding increase of 34 percent in the value of certified products. General improvement in the nursery trade, with a greater movement of dahlias, gladiolus, and chrysanthemums, accounted for this increase.

BARBERRY ERADICATION

There are several ways to measure benefits that farmers, processors, and the consuming public have derived from the barberry-eradication

program to date. Losses from stem rust of wheat that averaged more than 57 million bushels annually during the period 1916–20 have been reduced to an average of 20 million bushels annually for the period 1931–40, despite 2 years during this decade when comparatively heavy rust losses were experienced in the grain-growing areas of the upper Mississippi Valley States as a result of the south-to-north movement of rust for which local barberry bushes were not directly responsible. The total cost to the Federal Government to date of barberry eradication represents less than one-half of the resulting annual savings to grain growers. As the barberry population in grain-growing areas is further reduced, these savings will be increased and protection for future crops extended indefinitely. In addition, the control of stem rust has helped to eliminate wide fluctuations in yields and quality of grains produced in the United States, thus contributing in an important way to stabilization of production and prices. Perhaps the most important item of all, however, is the fact that if the organized control program undertaken in 1918 had been delayed a few years longer, losses from stem rust would have continued to increase and barberry bushes to become more prevalent, and the cost of equivalent control would have been immeasurably greater.

PRESENT STATUS OF CONTROL OPERATIONS

When the eradication of barberry bushes was undertaken in 13 North-Central States in 1918, it was known that they constituted the only local source of stem rust inoculum of any consequence in this area, and it was expected that the removal of existing bushes would greatly reduce, if not completely eliminate, widespread epidemics of the stem rust disease. Although the fact that rust developing on grains in the far South (southern Texas and Mexico), where the uredial stage of the disease lives over winter, has since proved to be a second but infrequent source of inoculum for grain fields in the upper part of the Mississippi Valley, it has not in any way detracted from the importance of completing the barberry-eradication program. There have been about 4 years in the past 20 when rust spreading from the South became epidemic in the Northern States in time to cause considerable damage, and these epidemics of southern origin have only once materially affected crops in States east of Iowa and Missouri.

To interpret accurately the present status of the barberry-eradication program, it must be understood that the earlier years of the control program were taken up largely with educational work, field demonstrations, and the application of approved control measures in limited areas where the more severe losses from stem rust were occurring. Before labor became available from emergency relief sources, a systematic scouting of extensive wooded areas where barberry bushes had escaped from cultivation could not be carried on because of a lack of funds.

With labor available from emergency relief sources during the last 6 years, an extensive survey has been made of a little more than 70 percent of the areas where a detailed inspection of all uncultivated lands is considered necessary in order to locate and destroy bushes that are growing along fence rows, rivers and streams, in pastures, and on timbered lands. Infested areas in the territory covered have

been carefully mapped, individual properties recorded, and other data compiled which clearly indicate where future reinspections will be necessary, thus eliminating from further attention much of the territory covered during the initial survey.

VARIABLE RATE OF PROGRESS IN SURVEY IN INDIVIDUAL STATES

At the close of the fiscal year 1941 progress that had been made in barberry eradication in individual States varied considerably. This was due largely to 3 factors, (1) the extent to which barberry bushes had become established before quarantines were enacted prohibiting further interstate trade in rust-susceptible species, (2) climate, soil, and other factors that have influenced the rate of natural spread of barberry bushes in established infestations, and (3) the time that has elapsed since the first barberry bushes were planted. The last factor is illustrated in Pennsylvania, where organized control work was first undertaken in 1935. Here planted barberry bushes have been found on only 1,920 properties, but more than 12 million bushes have been destroyed. In contrast, planted bushes have been found on more than 4,300 properties in Nebraska but only 146,000 bushes have been destroyed and the program is rapidly approaching completion. Few barberry bushes were planted in Nebraska prior to 1865, whereas in Pennsylvania they were reported as numerous in the settled areas as early as 1720. Thus, in Pennsylvania, as in other States comprising the eastern part of the control area, sufficient time has elapsed since the first bushes were planted to permit them to spread for great distances from the original source of seed, whereas in Nebraska areas of infestation immediately surrounding planted bushes are not extensive. While this situation is influenced to some extent by climate, the time element is an extremely important factor.

In North Dakota, South Dakota, Montana, Wyoming, eastern Colorado, and parts of Nebraska, Minnesota, and Missouri remaining barberry bushes are few and scattered and labor will be needed only in limited areas in the future. In North Dakota, South Dakota, Montana, and Wyoming, where no work was conducted during the year because of a reduced appropriation, field operations will be resumed in the fiscal year 1942. In these States further educational work is needed to inform property owners of the increased damage that rust will cause if seedling bushes are permitted to develop in known areas of infestation. Rust epidemics that develop locally indicate areas in which barberry bushes may have been overlooked and are continuing to serve as sources of inoculum. There are a limited number of locations in each of these States where at least one more systematic resurvey of timbered areas will be needed to insure complete eradication of seedling bushes.

ACCOMPLISHMENTS DURING THE YEAR

During the year 28,613,450 barberry bushes were destroyed on 5,443 properties in 248 counties. Of this number 27,021,466 were of the native species *Berberis canadensis* and *B. fendleri*. *B. canadensis* is found only in Virginia and West Virginia and in limited areas in Indiana, Illinois, Iowa, and Missouri. *B. fendleri* is restricted to southwestern Colorado. These native species of bar-

berry grow in patches and spread rather rapidly by means of root-stocks, which accounts for the large number of bushes reported in States where control work is concerned largely with them (table 8).

TABLE 8.—*Progress in barberry eradication, by States, fiscal year 1941*

State	Counties surveyed	Area surveyed	Properties cleared of bushes	Barberry bushes destroyed		Salt used
				Berberis vulgaris	*Berberis fendleri* and *B. canadensis*	
	Number	*Square miles*	*Number*	*Number*	*Number*	*Tons*
CONTROL WORK BEGUN IN 1918						
Colorado	10	800	206	1,404	2,783,585	0.82
Illinois	15	2,102	299	2,911		5.25
Indiana	35	2,312	269	2,860		7.18
Iowa	37	3,612	435	4,017		20.48
Michigan	17	1,831	290	2,247		14.45
Minnesota	21	5,416	322	1,745		39.41
Montana [1]						
Nebraska	34	14,977	40	114		.27
North Dakota [1]			2	8		.04
Ohio	13	1,688	323	7,718		12.73
South Dakota [1]		29				
Wisconsin	22	2,274	770	11,861		37.88
Wyoming [1]						
Subtotal	204	35,041	2,956	34,885	2,783,585	138.51
CONTROL WORK BEGUN IN 1935						
Missouri	13	3,157	69	343		0.79
Pennsylvania	16	1,979	1,782	1,555,505		515.53
Virginia	9	361	459	1,051	11,420,630	601.80
West Virginia	6	176	177	200	12,817,251	451.95
Subtotal	44	5,673	2,487	1,557,099	24,237,881	1,570.07
Grand total	248	40,714	5,443	1,591,984	27,021,466	1,708.58

[1] Work to be resumed in July 1941.

AID BY COUNTY GOVERNMENTS AND LOCAL AGRICULTURAL AGENCIES IN BARBERRY ERADICATION

The aid given the barberry eradication program by counties and other local agencies was increased materially during 1941. Contributions included (1) trucks for transportation of workers and supplies, (2) gasoline, oil, and maintenance and storage for Government-owned automotive equipment, (3) mileage allowance for privately owned cars used for the transportation of workers, (4) chemicals for treating barberry bushes, and (5) miscellaneous purchases, including boots for men who were required to work in swampy areas.

In a few instances counties have joined with the Bureau of Entomology and Plant Quarantine in sponsoring local W. P. A. projects, but in most instances their contributions have been used to supplement funds available from W. P. A. sources for purposes other than labor.

Farmers continued their active participation in the program by supplying labor, teams, and tractors for hauling chemicals and equipment, and providing storage for chemicals and other supplies. They contributed their own services or hired men to make up eradication crews, but contributed labor was accepted only when experienced supervisors were available to direct control operations and to map the infested areas encountered.

SPECIAL TRAINING OF MEN EMPLOYED ON BARBERRY ERADICATION

Increased attention was given during the year to training laborers, foremen, and supervisors paid from W. P. A. funds. Movie films and lantern slides, supplemented with instructions from State leaders and their assistants, were used the better to acquaint laborers with the entire stem rust control program. In several States regular training periods were scheduled, usually in the evening, with attendance voluntary. In most instances 100 percent of the crew members were present. Special training was given foremen and supervisors, with particular emphasis on survey procedure, checking methods, and efficiency of operation. In some cases laborers showed considerable interest in the identification of common trees and shrubs in addition to the rust-susceptible barberry.

A striking example of the value of this type of training was evidenced by workers in Iowa. A small planting of native barberry (*Berberis canadensis*) was found in the course of regular survey operations in Davis County, and in spite of the fact that these shrubs differ considerably in appearance from the common barberry, they were found by a laborer who had learned to recognize certain other trees and shrubs. This is the first record of the finding of *B. canadensis* in Iowa.

DISCONTINUED PROPAGATION OF SUSCEPTIBLE SPECIES OF BARBERRY BY MORE NURSERIES

An indication that nurseries interested in the interstate shipment of barberry bushes are gradually eliminating from their stock species other than those that are rust immune may be found in the fact that in 1938, 25,750 barberries were destroyed as a result of an inspection of 46 nurseries; in 1939, 9,414 bushes were destroyed when 49 nurseries were inspected; and 608 bushes were destroyed in 1940 as a result of an inspection of 63 nurseries covering 17,500 acres.

More than 250 barberry specimens were received for identification during the year. Fifty herbarium specimens from China have been checked and inserted in the herbarium, and 125 literature citations have been added to the barberry index. The preparation of a visible card index of the family Berberidaceae has been undertaken.

RESTRICTION OF STEM RUST DAMAGE TO SMALL AREAS IN 1940

No general epidemic of stem rust developed in 1940. The fall of 1939 was abnormally warm and dry, and during October and November stem rust was scarce on wheat and oats in the Central States. Scattered infections on oats in Texas in December appeared to have resulted from urediospores blown from Mexico during November. Stem rust had lived over the summer at high altitudes in northern Mexico, and in October there was an unusual amount of infection on wheat, barley, and oats. Stem rust also apparently lived over the winter of 1939–40 in the area about Monterrey, Saltillo, and Sabinas Hidalgo, where heavy infection was observed in occasional fields late in March. Considerable rust developed after early April rains, making this region a possible source of inoculum for Texas and States farther north.

Stem rust overwintered in southern Texas on oats, and circumstantial evidence indicated that the rust survived on wheat also.

Rust began to spread from these centers on oats in the extreme south as early as February, although not until April in the wheat area west of San Antonio, where it was dry. About April 1 spores also were carried from fields in northern Mexico as far north as southern Oklahoma. By May 10, when stem rust often has only begun its development in northern Texas grain areas, there was 50 percent of stem rust in centers of infection that were so numerous in susceptible fields as to be coalesced. Despite this early severe infection in the South, however, the threat of a destructive epidemic did not materialize.

Spore distribution early in the season was limited by lack of strong south winds, and rust development in general was slow. Considerable acreages of late grain in both winter and spring wheat areas and variations in moisture supply resulted in a spotted condition in general, so that rust damage was local rather than regional. Drought prevented appreciable rust development in the Waco area of central Texas, in much of Nebraska, and in the western part of North Dakota and South Dakota. Stem rust became heavy enough to cause appreciable damage, however, in north-central Texas, south-central Oklahoma, in late fields in northern Oklahoma, in south-central and east-central Kansas, in western Missouri south of the Missouri River, and along the Missouri River in northeastern Nebraska and adjoining parts of Iowa. Rust also became destructive in scattered fields of susceptible bread wheats in southern Minnesota, in five counties of northeastern Montana, and in one durum-wheat area of North Dakota.

Considerable infection also developed in various areas where soft red winter wheat is grown, including the territory along the Illinois River in Illinois and in southern Indiana, where as much as 25 percent damage was attributed to stem rust. Rust also was more prevalent than usual in much of lower Michigan.

DAILY MEASUREMENT OF SPORE CONTENT OF AIR

Examination of slides coated with petroleum jelly exposed daily throughout these grain-growing areas during the critical rust season indicated that there were few stem rust spores in the air during May north of Texas or Oklahoma, although spores were abundant at Dallas, particularly during the second half of the month. Northward distribution was limited by lack of strong south winds, particularly early in the season, and subsequent infection in some areas was prevented by lack of rainfall after the falling of showers of spores. Not until after the middle of June were there appreciable numbers of spores in the air over the spring-wheat area.

RAPID INCREASE OF PREVALENCE OF RACE 17

The most striking feature of the physiologic-race survey of wheat stem rust in 1940 was the conspicuous increase in prevalence of race 17. Race 17 had been increasing slowly for about 10 years; then in 1939 it became noticeably more prevalent, and in 1940 it constituted 34 percent of all isolates identified. At the same time race 56 continued to decrease slightly, dropping from 55.5 percent in 1939 to 43.6 percent in 1940. The bulk of the race population in the United States, however, remains much the same as in recent years, with races

56, 17, and 38 together constituting about 88 percent of the total number of isolates obtained from wheat. While this situation persists, Kanred wheat and varieties derived from it, including Thatcher, may be expected to remain highly resistant or immune to the stem rust disease. The same 3 races constituted a considerable proportion of the race population in northern Mexico also, with an increase in race 17 evident in that region as well as in the United States, thus indicating again the probability of considerable exchange of rust inoculum between the two regions.

IMPORTANCE OF BARBERRIES AS A SOURCE OF NEW RACES OF STEM RUST

Races of stem rust identified from infected barberry leaves in 1940 had a much wider host range than races obtained from grain plants, thus adding to the evidence that barberry bushes are extremely important in the production and perpetuation of races of the stem rust fungus. There was further evidence this year that there must be a definite sequence and synchronization of factors for several months in advance of the development of a destructive epidemic of stem rust that originates in the South. This makes long-range predictions relative to rust losses practically impossible.

In the fall of 1940 spores were blown in considerable quantity from badly rusted volunteer grain plants in Northern States into the winter-wheat areas of Texas and Oklahoma. Owing to favorable weather conditions, infection on fall-sown grain became quite general, thus suggesting the possibility of widespread overwintering, resulting in an abundance of inoculum in the spring of 1941. Subsequent events, however, proved that very little of the rust present in the fall of 1940 survived the winter, and the spring build-up of inoculum was relatively slow. There is nothing particularly unusual about large quantities of stem rust spores drifting from north to south in the fall. The important thing is to what extent fall infection in northern Mexico and Texas survives the winter.

The relative importance of a local source of inoculum as compared with one some distance away was clearly illustrated in 1941. Wherever barberry bushes existed in the northern plains area they rusted heavily, and spores from these local centers were being distributed to grains and grasses several weeks in advance of spores from southern grain fields. Had there been large numbers of barberry bushes in or adjacent to important grain-growing areas of the Northern States this year, it is quite possible that a very destructive epidemic of the stem rust would have resulted.

TRUCK CROP AND GARDEN INSECT INVESTIGATIONS

The truck crop and garden insect investigations have been continued with a view to the development of methods and means of reducing losses to vegetable crops such as tomatoes, beans, peas, peppers, potatoes, cabbage, and cauliflower by such insects as the tomato fruitworm, the tomato pinworm, the pea weevil, the pea aphid, the pepper weevil, the Mexican bean beetle, the lima bean pod borer, the potato psyllid and potato aphids, wireworms, and cabbage caterpillars; to growing and stored tobacco by flea beetles, hornworms, thrips, sod webworms, the cigarette beetle, and the tobacco moth; to

sugar beets by the beet leafhopper, the beet root maggot, and plant bugs; to greenhouse plants, bulbs, and mushrooms by thrips, red spiders, bulb flies, insect carriers of plant diseases, and mushroom flies; and to blackberries, raspberries, and loganberries by the raspberry fruitworm and the red berry mite (*Eriophyes essigi* Hassan).

Emphasis in many of these investigations has been placed on the commecial applications of the results obtained from the various experimental operations, with attention focused on the cost of the treatments in relation to crop yield and quality.

The work of the Division has been affected indirectly by war conditions abroad. The storage of tobacco in this country, occasioned by the decline in exportations because of war conditions, has resulted in the assignment of an entomologist to advise in the selection of suitable storage houses from the standpoint of insect control.

The curtailment of importations of sugar beet seed from Europe has resulted in an increase in the acreage devoted to the growing of sugar beets for seed in this country and has emphasized the need for adequate control of the insects that feed on beet seed pods and reduce not only the yield but the viability of the seed.

New work was undertaken in Maine on aphids affecting potatoes. While serious aphid infestations have occurred sporadically for many years in the Maine potato fields, during the last several years these infestations have been of a damaging character each season, not only reducing the yield of the crop but transmitting diseases to the potato plant, an important disease, as it affects the Green Mountain variety, being leaf roll. This disease affects both potatoes grown for seed and those grown for culinary purposes.

Assistance was given to the Utah State officials and the pea-producing industry in that State by the assignment of an entomologist to aid in the inauguration of an extensive control program to prevent pea weevil infestations in peas grown for processing.

In conjunction with Federal aid to the growers of vegetable crops in Florida for the control of mole crickets, entomologists were assigned to make surveys of the infestations and to conduct studies on a minimum effective dosage of the poisoned bait to be applied per acre for mole cricket control. This work also involves a study on bait composition and the effect of storage on the deterioration of bait.

The past season's work in the Puyallup Valley of Washington has demonstrated very clearly that the schedule of treatments developed for the control of the raspberry fruitworm and the red berry mite are effective from the commercial growers' standpoint. These investigations are now considered as completed for all practical purposes. Studies on the raspberry fruitworm have brought to light the fact that the raspberry fruitworm of the Northwest, which was formerly considered as *Byturus unicolor* Say, is an undescribed species.

The investigations of the natural enemies of the European earwig, which have been conducted at Puyallup, Wash., have been brought to a successful conclusion. The parasite *Bigonicheta setipennis* (Fall.) has been reared in large numbers and distributed and colonized successfully in several widely separated localities. Preliminary studies on another parasite, *Rhacodineura antiqua* (Meig.), indicated that the difficulties involved in rearing this parasite in large numbers did not justify continuation of this work.

POTATO INSECTS

The biological studies conducted on the potato psyllid have not as yet revealed the source of infestation or the overwintering quarters of the psyllids which infest potatoes in the North Platte Valley of Wyoming and Nebraska, nor has any success followed the attempts to carry the insects in an artificial environment through the winter out of doors. In all these attempts by various types of cover, 100 percent mortality of insects has occurred in every instance.

During the season, in active cooperation with the Washington Agricultural Experiment Station, work was initiated on the biology and control of two species of flea beetles that attack potatoes in the Northwest, namely, *Epitrix cucumeris* (Harr.), and *E. subcrinita* Lec. These two insects are apparently becoming an increasing menace to the successful production of potatoes in some areas, the species which is now being called *Epitrix cucumeris* causing the greater damage.

The one season's study of aphids attacking potatoes in Maine, a project conducted cooperatively with the Maine Agricultural Experiment Station and the potato growers of the State, has yielded some interesting results. It was found that a combination spray consisting of derris, peanut oil, and insoluble copper increased the yield of potatoes but did not reduce the leaf-roll disease. In one instance the yield of potatoes was increased 77 percent over that of the untreated plots, or 523 bushels per acre. In the check or untreated plots less leaf roll occurred, whereas in the plots where the aphid control was the highest the percentage of leaf roll was likewise the greatest. The explanation for this may lie in the fact that the sprayed potatoes remained in a good growing condition about 2 weeks longer than the unsprayed checks, thus giving the aphids an opportunity to transmit the disease over a longer period of time. Three species of aphids are involved, namely, the green peach aphid, the buckthorn aphid, and the potato aphid.

WIREWORMS

The investigations that have been conducted in California, Washington, and Idaho on the wireworm problem on irrigated lands have included a study of crop rotation, the withholding of irrigation water, the incorporation of chemicals in irrigation water when applied to the crop, and the direct application of chemicals to the soil as a means for the control of these soil-infesting pests.

In Idaho, in cooperation with the Idaho Agricultural Experiment Station, another season's results on the relation of certain crop practices to the trend of wireworm populations in the soil show that the average number of wireworms has dropped from a range of 6 to 10 in 1937 to 3 wireworms per square foot in 1940 in plots which have been in alfalfa since 1937. In plots where the cropping of the alfalfa was broken by a season in potatoes, corn, wheat, or sugar beets, there has been no important change in the wireworm populations over the initial infestation. From the experiments which have been carried on at Prosser, Wash., it has been found that for a 2-year period the highest population of wireworms occurred in the potato and wheat plots, whereas in the alfalfa, sugar-beet, and corn plots the populations were relatively low. Alfalfa plantings of 2-

and 3-year stands contained significantly fewer wireworms than did plantings of 1-year stand. These results strongly indicate the value of 3- or 4-year successive cropping of alfalfa as a means of reducing wireworm populations, especially in heavily infested lands.

The effect of withholding irrigation water, or soil drying, on the development of the new brood of wireworms has been that in cases where no water was used until after the first cutting of alfalfa no new brood of wireworms was to be found in the plots, whereas in the plots that were irrigated normally an average of 1.6 wireworms of new brood were found per square foot. The practical value of withholding irrigation water until after the first cutting of alfalfa was demonstrated by the results obtained in a field at Grand View, Wash. In this instance for 3 successive years no water was applied after the first cutting of the alfalfa. Potatoes planted the fourth season yielded a crop from which there was no commercial loss because of wireworm feeding scars on the tubers.

At Ventura, Calif., where a study is being conducted on the effect of winter cover crops on wireworm infestations, one season's results have shown that crops such as barley, mustard, clover, vetch, and fenugreek grown for soil improvement have had no effect on the wireworm populations. The yield of beans following these various cover crops was practically the same for each plot. The indications are that the winter cover crop is not likely to affect wireworm populations adversely or otherwise.

In two large-scale demonstration experiments with crude naphthalene on two types of soil, it was shown that the type of soil was a definite factor in the effect of naphthalene on the wireworms. In the silt-loam type of soil control was not satisfactory, the mortality being less than 15 percent, whereas on a sandy-loam type the kill of wireworms was considered as satisfactory, ranging from 70 to 80 percent. In both instances the naphthalene was applied at the rate of 800 pounds per acre to each side of the furrow as it was turned by the plow. Further mixing of the naphthalene with the soil was accomplished by disking.

In experiments at Walla Walla, Wash., dichloroethyl ether showed some repellent effect on wireworms, but its beneficial action was offset by a decrease in yields of the treated potatoes, and plant injury resulted on field and sweet corn and on cantaloup. The cantaloup, however, showed a greater tolerance to the chemical than did any of the other crops. When dichloroethyl ether was applied with the irrigation water, plant injury was apparent after two irrigations, and the treatments did not prevent damage to potato tubers by wireworms. The chemical also imparted an undesirable taste to the tubers which was noticeable after cooking. It was evident from these experiments also that the type of soil influenced the effectiveness of the material.

SUGAR BEET INSECTS

Investigations of insects affecting sugar beets have been continued in Idaho, Arizona, and California. The biological phases have dealt primarily with the study of the importance of various wild plants as hosts of the beet leafhopper, such information being of value in connection with range-rehabilitation or land-planning programs.

Studies have been made of the relative importance of the various species of plant bugs as pests of sugar beets grown for seed.

Another phase of the problem has been a study of the insecticidal control of the beet leafhopper and the various species of plant bugs. The seasonal abundance of the beet leafhopper in southern Idaho is still another phase of this study which is of interest to the growers of beets and beans.

In the spring of 1941, in southern Idaho, the leafhopper populations were the greatest ever recorded during recent years. This was due to excessive rains, which caused an abundant and widespread germination of fall, winter, and spring wild host plants. The initial movement of the leafhopper to the cultivated areas occurred on May 12 and continued in progressively increasing numbers until May 25, when the intensity of the movement was retarded by cool, rainy weather which prevailed for about 2 weeks. After this unfavorable period the number of leafhoppers moving into the cultivated districts each day increased again until the peak of the populations, consisting on the average of nearly 15 leafhoppers per sugar beet plant, was reached by the middle of June. A survey of the sugar beet fields in July revealed that nearly 85 percent of the plants were infected by curly top, constituting a higher percentage of infection than has been recorded in recent years. It is evident, considering this high percentage of disease, that if the leafhopper movement into the beet fields had not been delayed by the cool, rainy period mentioned, and the young beets had been subjected to early infection, the losses would have been much greater than was the case.

The results of the studies of insecticidal treatment for leafhopper control of beets grown for sugar indicate that a combination of pyrethrum and lime-sulfur may be used to advantage, especially in the protection of young beets from curly top infection. Data show that sulfur and various combinations of lime and sulfur applied in the form of a spray or dust exerted a pronounced control of the beet leafhopper nymphs through the medium of direct action plus their residual effect. Small nymphs were more readily killed than large nymphs, and the treatment did not have any appreciable effect upon the fifth instars. Liquid and dry lime-sulfur gave practically the same percentage of control. The addition of arsenicals to the lime-sulfur did not increase the toxicity of the sulfur, and the indications are that it decreased its effectiveness. The residual effect of a lime-sulfur spray against the nymphs lasted for approximately 3 weeks after application of the material to the plant.

While it has been known for some time that sprays of combined pyrethrum and oil were effective as direct contact insecticides against the beet leafhopper, the use of these materials was limited because of the short period of their effectiveness. From laboratory and field tests completed thus far, the development of a pyrethrum and lime-sulfur combination spray will remedy this defect and provide an insecticidal treatment for use against heavy infestations of the beet leafhopper when the plants are small. It has been estimated by sugar-company officials in south-central Idaho that losses from beet leafhopper infestations, even on varieties of sugar beets resistant to curly top, approximate 2 tons of sugar beets per acre. On the

basis of 22,000 acres harvested each year in this area this would mean an annual loss of $264,000. Therefore the development of a satisfactory insecticidal treatment is a matter of considerable importance to the sugar beet growers and the industry.

From investigations on insects affecting sugar beets grown for seed it has been found that only two species of plant bugs, the tarnished plant bug (*Lygus pratensis* var. *oblineatus* (Say)) and *L. hesperus* Knight, cause severe damage to the developing beet seed. A third species, *L. elisus* Van Duzee, was found to exercise very little detrimental effect on the development of the sugar beet seed or its viability.

Insecticide tests in the field directed against the two principal species of *Lygus* bugs attacking beets grown for seed in the Salt River Valley of Arizona and in the Mesilla Valley of New Mexico have demonstrated that the populations of these pests could be reduced appreciably, with a resultant definite increase in the percentage of viable seed produced on the treated plants, by the application of dusting sulfur or by the use of dust mixtures containing either a dust impregnated with pyrethrum extract or a derris dust. Sprays containing either a pyrethrum-oil extract emulsified in water or a water-soluble pyrethrum extract were not so effective against *Lygus* bugs on sugar beets as were the dust mixtures.

Continued tests on a commercial scale by the growers gave further evidence that a pyrethrum-in-oil spray applied in an atomized form early in the fall to young sugar beet plants grown for seed provides an effective control for the beet leafhopper and the curly top which it transmits. In one series of tests, wherein 500 acres of a variety of sugar beets susceptible to curly top were treated in October 1940 with the pyrethrum-in-oil spray, an examination in May 1941 disclosed that the number of plants infected by this disease was reduced approximately 45 percent in the sprayed plots as compared with adjacent or nearby unsprayed plots. The severity of curly top infection was lower, moreover, in the sprayed than in the unsprayed plots.

INSECTS AFFECTING GREENHOUSE AND ORNAMENTAL PLANTS AND MUSHROOMS

Investigations have been continued on the control of red spiders and thrips as they affect greenhouse-grown cucumbers, and it has been found that an alcoholic extract of pyrethrum and sulfonated castor oil is an effective remedy, as the production of the cucumber crop in the greenhouse was prolonged by these treatments.

In tests with methyl bromide and lime-sulfur sprays against the cyclamen mite on cyclamens, delphiniums, chrysanthemums, Saintpaulia, and snapdragons, it was found that these materials may supersede the heretofore recommended hot-water treatments for the control of the cyclamen mite.

Investigations in cooperation with the plant workers on the development of an aster resistant to yellows and a chemical control for the leafhopper which transmits the aster yellows disease have not been very successful. All tests failed to disclose any varieties of aster that showed resistance.

Studies on the virus or mosaic diseases of lilies have shown that these plant disorders are disseminated by three species of aphids and possibly by other insects.

Investigations on the control of the gladiolus thrips as a pest of the foliage and flowers of gladiolus have definitely corroborated the earlier results and, in addition, have led to the recommendation of a weaker spray, the formula now recommended being 2 pounds of tartar emetic and 4 pounds of brown sugar in 100 gallons of water.

The investigations on insects affecting flowering bulbs have dealt primarily with field control of the narcissus bulb fly in the Pacific Northwest. The results have shown that a spray consisting of lead arsenate and an oil emulsion in water, similar to the one used against the codling moth in the Northwest, will reduce bulb fly infestations in the field. Tests with lead arsenate and the oil emulsion used separately did not yield the same results. Screening of the field-grown narcissi with cheesecloth, while effectively preventing oviposition by the bulb fly, resulted in the loss of weight of bulbs produced under the screens.

Experiments with chemicals as attractants to the bulb flies have yielded no results of value. Extensive surveys in the bulb fields of Oregon and Washington during the past season have shown that an average of 5.85 percent of the bulbs are affected by the bulb fly. This figure is higher than that obtained during similar surveys conducted each year since 1935.

In the investigations of pests affecting mushrooms, emphasis has been placed on methods of treating the mushroom beds for the control of flies and mites. Encouraging results have been obtained with pyrethrum extracts and dichloroethyl ether used as drenches. Beds treated with these drenches give marked increase of yield as compared with beds not treated.

Mushroom beds in which tobacco dust had been incorporated with the compost before the latter was placed in the houses yielded a greater production of mushrooms than beds that did not contain the tobacco dust.

Experiments with aerosols (insecticidal smokes) against the mushroom flies gave encouraging results.

An inexpensive suction light trap has been devised which will be used as a substitute for the large, cumbersome, and expensive fans now in operation in some mushroom houses.

A study of the biology of the mushroom mite *Tyroglyphus lintneri* Osb. has been completed.

TOBACCO-INSECT INVESTIGATIONS

Work under the tobacco-insect project has been conducted in the areas where flue-cured tobacco is grown, the areas producing dark fire-cured tobacco, the areas in Connecticut and Florida where tobacco is grown under shade, and on pests found on stored tobacco.

Further experiments with attractants and traps for the collection of hornworm moths have resulted in the development of a small trap of less than 15 cubic feet equipped with two or four large green-wire entrance funnels. This trap appears to be the most effective of all those tested over a period of 5 years or more. In tests with this trap during the past season the indications were that a trap painted yellow, red, or green was more effective than one painted gray, aluminum, or blue. Of the several chemicals tested, the isoamyl salicylates were more attractive than any others. However, the attractive-

ness of different lots of isoamyl salicylate varied to a considerable extent. The reason for this variation is not apparent.

At Florence, S. C., and Clarksville, Tenn., tests conducted on the control of larvae of the green June beetle in tobacco plant beds by the use of a bait consisting of 1 pound of paris green to 25 pounds of wheat bran failed to give satisfactory control. From a series of experiments at Oxford, N. C., however, it was concluded that this poisoned bait is a satisfactory remedy when applied to the tobacco beds early in the season. The conflict in the results obtained at these various localities would indicate that further work is necessary to determine the effectiveness of a poisoned bait under all conditions for control of the larva in the tobacco bed.

In the hornworm-control experiments in South Carolina, fields of three growers were used to compare a spray consisting of 6 pounds of synthetic cryolite to 50 gallons of water with a spray composed of 2 pounds of lead arsenate to 50 gallons of water. The sprays were applied with a mule-drawn traction sprayer equipped in such a way that from four to six nozzles per row could be used for any one application. Since the fields were being treated for commercial control, applications were made before the hornworms had reached damaging numbers, and one field received three applications of the two sprays, one four applications, and one five applications. A study of the injury on the plants before any of the leaves were harvested showed that the lead arsenate was definitely superior to the cryolite spray. The damage in all the treated fields was small, however, and it would appear that, with the addition of a sticker, cryolite sprays could be used successfully for hornworm control. These results would indicate that excessive quantities of lead arsenate can be avoided on tobacco by the use of a spray, since in these experiments about 3 pounds of the lead arsenate were used per acre per application.

The tobacco moth, since its discovery as a pest in the pack houses in 1938, continues to be present in many pack houses; and, while the infestations were not so heavy in 1940 as in 1939, some damage has occurred. The economic damage seems to be confined to the heavily infested premises where no efforts were made to clean the pack houses thoroughly just prior to the storing of the cured tobacco. These investigations have shown that the tobacco moth is able to maintain itself in pack houses without difficulty under conditions existing in the infested areas of North Carolina, where its food materials, such as the tobacco debris found in pack houses and the remnants of various farm crops and foodstuffs, such as corn and soybeans, are available.

The experimental work on pack-house sanitation indicated definitely that the infestations of the tobacco moth can be reduced economically by disposing of all scrap and trash tobacco and thoroughly cleaning the pack houses as soon as the crop has been removed for marketing. In instances where the crop can be disposed of before the larvae enter hibernation, a thorough cleaning early in the spring before moth emergence has been found to be of value in reducing subsequent populations of tobacco moths.

The fumigation of open-storage warehouses for the control of the cigarette beetle and tobacco moth with hydrocyanic acid gas, wherein

a gasproof curtain is used to enclose the gas, appears to be entirely feasible, as judged by the large-scale experiments conducted in 1940. The gasproof curtain is utilized to seal the walls or sides of the warehouse where the openings are provided for ventilation. The curtain is hung from the top, weighted at the bottom, and sealed at the top edge with material of a temporary nature. A dosage of 12 ounces of liquid hydrocyanic acid per 1,000 cubic feet of air space appeared to give good penetration into the stored tobacco, effecting a satisfactory reduction of the insect populations.

From observations made on 3,300 hogsheads of flue-cured tobacco held in cold storage during the summer of 1940 at temperatures of 55° to 65° F., the indications are that this method of storage would be entirely satisfactory both from the standpoint of the effect of temperatures on the tobacco and from that of insect control. The relative humidity in cold storage must be carefully controlled, or the excessive moisture may cause some damage to the tobacco.

SWEETPOTATO WEEVIL CONTROL AND ERADICATION

The sweetpotato weevil is recognized as the most destructive insect pest attacking the sweetpotato crop. Farmers in Georgia, Alabama, Mississippi, and Texas, States in which the Federal-State activities against the weevils are conducted, received more than $21,000,000 for their 1939 crop. These activities of the last 5 years have resulted in the apparent eradication of the weevils from 1,257 properties in the commercial areas where eradication is the objective, representing more than 87 percent of the properties found infested in these areas. During the year 2 counties in Georgia, 5 in Mississippi, and 2 in Texas were released from quarantine as apparently free from weevils.

In Georgia, Mississippi, and Texas the work is now centered largely upon the areas bordering the counties which have been rid of the pest.

In Alabama the work to date has resulted in eradication of a large percentage of the infestations in Baldwin County, in which the sweetpotato industry is represented by more than 5,000 acres. Eradication measures are going forward in Mobile and Butler Counties, weevils having been discovered in the latter county during the year.

In northern Louisiana, during the summer and fall of 1940, inspection was conducted by Federal and State inspectors in the area lying outside that in which weevils were known to be rather generally distributed. No infestations were found in the 28 northern parishes inspected.

The various participating States have enacted quarantines on the movement from infested areas of sweetpotatoes and sweetpotato plants, and regulations requiring sanitation practices in their planting and handling.

MOLE CRICKET CONTROL

In the fall of 1940 outbreaks of mole crickets in truck-crop plantings, especially strawberries, became so severe in 11 Florida counties that growers made a formal appeal through their county and State governments for Federal assistance. After a field survey had been made, which gave evidence of a community problem beyond the means of local control, 1,258 tons of poisoned-bait materials, consisting of bran

and calcium arsenate, were made available by the Bureau under funds allotted for the control of incipient and emergency outbreaks of insect pests and plant diseases. The work was organized in close cooperation with State pest-control agencies under signed agreements with the county governments, the State handling the distribution and the counties the transportation from mixing stations. More than 5,000 growers spread the poisoned bait over 30,700 acres of crops. Very effective control was accomplished throughout. It is believed that without such assistance many commercial plantings would have been severely damaged or destroyed by these burrowing crickets.

COTTON INSECT INVESTIGATIONS

BOLL WEEVIL

The effects of the severe winter of 1939–40 on the survival of the boll weevil were reflected in the light damage caused to the 1940 cotton crop. Although boll weevils entered hibernation in large numbers in the fall of 1939, the extremely low temperatures reduced the survival to such an extent that the populations did not reach normal numbers until late in 1940. Consequently losses in yield due to weevils were reduced from 32 and 23 percent in Virginia and North Carolina in 1939 to 2 and 1 percent, respectively, in 1940. Losses from weevils were reduced from 8 percent in 1939 to 4 in 1940 in South Carolina, from 14 to 10 percent in Georgia, from 18 to 12 percent in Alabama, and from 13 to 10 percent in Mississippi. The estimated damage in Louisiana was 10 percent and in Texas 7, or 2 percent greater in each of these States than in 1939. The average reduction from full yield due to weevils was 6.5 percent in 1940, as compared with 8.6 percent for the 10-year average. Defoliation of cotton by leaf worms was negligible, and the abundance of food late in the season permitted above-normal numbers of well-fed weevils to enter hibernation in the fall of 1940. As a result of the large number of weevils entering hibernation and the mild winter of 1940–41 more weevils survived than for many years. In 1941 the percentage of emergence from hibernation cages at Florence, S. C., was 10; at McIntosh, Fla., 17.6; at Tallulah, La., 10.4; and at Waco, Tex., 14.8. Emergence was delayed by early-season drought in the Southeast, and a large proportion of the weevils emerged after squares were available for food and conditions favorable for multiplication. Rains in areas west of the Mississippi River delayed planting and fruiting of cotton and made early-season conditions extremely favorable for a rapid build-up and a sharp upturn in damage to the 1941 crop.

For the first time since boll weevil control investigations were started at Florence, the field tests of 1940 were of little significance. This was because the low winter survival, followed by hot, dry weather early in the season, prevented weevils from increasing to injurious numbers until after the crop was mature. At Tallulah the rainfall was 6 inches above normal during June and July, and from a low winter survival weevils increased rapidly and caused severe losses.

The average gain in plots dusted with calcium arsenate at Tallulah was 551 pounds of seed cotton per acre, or 54 percent above the checks, the highest percentage of gain since 1926. At Waco the average

increase in yield in plots dusted with calcium arsenate was 458 pounds of seed cotton per acre as compared with only 31 pounds in 1939.

Results of tests with commercial calcium arsenates with different chemical and physical properties were similar to those of previous years in that calcium arsenates with high water-soluble arsenic as determined by the New York method caused greater weevil mortality in cage tests but did not give significantly greater gains in field tests than did the calcium arsenates containing low or intermediate water-soluble arsenic. Aphid populations increased in proportion to the water-soluble arsenic content of the calcium arsenate and in some experiments caused premature shedding of leaves and reduction in yields.

Experiments conducted at Tallulah each year since 1934 (19 replicates) to determine the effect of applying calcium arsenate for boll weevil control at different times of the day showed that applications made early in the morning when the plants were wet with dew, as usually recommended, gave an average increase over the checks of 287 pounds of seed cotton per acre, applications at midday 282 pounds, and applications late in the afternoon 232 pounds. These experiments have been of interest and importance to growers in indicating that the recommended practice of dusting at night or early in the morning while the plants are wet with dew could be avoided and that the acreage covered by dusting machines could be increased because of the longer dusting period. In another series of tests including 29 replicates over this 7-year period, applications of calcium arsenate dust at 4-day intervals gave an average increase over the checks of 178 pounds of seed cotton per acre, those at 6-day intervals 101 pounds, and those at 8-day intervals 76 pounds. In 1940 applications of calcium arsenate dust beginning when 8, 25, and 70 percent of the squares were infested were followed by average increases in yields over the checks of 522, 580, and 350 pounds of seed cotton per acre, respectively. In other experiments in 1940, 6 applications of calcium arsenate dust, 3 of which were made before and 3 after summer dispersal of weevils started, gave an average increase of 424 pounds of seed cotton per acre, 3 applications before dispersal 140 pounds, and 3 applications after dispersal 332 pounds. The accumulation of results continues to indicate that larger gains per application are obtained from late-season applications than from early applications.

Tests comparing spraying and dusting for boll weevil control were inaugurated at Waco in 1939 and continued in 1940 because of the increased demand from growers for more definite information on the relative effectiveness of those methods of application for cotton insects. In central Texas winds and lack of dew sometimes prevail during a considerable portion of the time when control measures should be used, and farmers would welcome a spray program that would economically control cotton insects. Calcium arsenate and lead arsenate were applied with a four-row, tractor-drawn sprayer with three nozzles per row in comparison with calcium arsenate applied with single-row rotary dusters. In 1939, when there was a light weevil infestation, the plots sprayed with lead arsenate produced slightly more than those dusted with calcium arsenate, but in 1940, under conditions of heavy infestation, the calcium arsenate dust gave much better control and greater profits than either calcium arsenate or lead arsenate spray.

In further tests with cryolite containing different percentages of sodium fluoaluminate for boll weevil control, mixtures of cryolite and sulfur containing 30 percent and 35 percent of sodium fluoaluminate gave practically no control, while undiluted cryolite containing 89 percent of sodium fluoaluminate was about half as effective as calcium arsenate dust.

Studies were started on the weevil damage to sea-island bolls produced at different dates by tagging blooms throughout the season and determining the damage to individual locks. Under the conditions of light initial infestation that occurred in 1940 very little damage was caused to bolls from blooms occurring before July 20 on dusted cotton, while bolls from July 1 blooms on undusted cotton were considerably damaged. These results indicate that in the case of sea-island cotton, where quality of lint is such an important factor, it may be more profitable to begin dust applications when the weevil infestation is lighter than on short staple, as the early bolls that mature before weevils become abundant are an important part of the crop.

Spraying sea-island cotton with lead arsenate and calcium arsenate and dusting with calcium arsenate-sulfur mixtures have given fairly satisfactory control early in the season when the weevil infestation is light but have not given such good control or increase in yields as dusting with undiluted calcium arsenate. Mopping with a 1: 1: 1 mixture of molasses, calcium arsenate, and water has likewise failed adequately to control weevils on the experimental plots or when applied by growers under farm conditions.

COTTON FLEA HOPPER

The infestation of the cotton flea hopper was comparatively light in Texas in 1940 as in 1939, and the control experiments at Port Lavaca and Waco did not show substantial gains in yields from the different insecticidal treatments. The highest gain at Port Lavaca was 86 pounds and at Waco 69 pounds of seed cotton per acre from applications of 1:2 calcium arsenate-sulfur dusts. The four-variety Latin-square experiment for flea hopper resistance was continued and again showed a marked difference in susceptibility of varieties to infestation and injury.

LEAF APHIDS

The increase in the cotton leaf aphid damage following the use of calcium arsenate continued to be the most serious objection regarding this insecticide for the control of cotton insects. Experiments were conducted in South Carolina, Louisiana, and Texas employing a factorial design to determine the comparative effect on cotton yield of treatments with calcium arsenate dust for the boll weevil, nicotine dust for aphids, and a combination of the two treatments. The increased yields following applications of both calcium arsenate and nicotine dust over calcium arsenate alone varied considerably in different areas, but averaged 90 pounds of seed cotton per acre, which may be considered an estimate of the reduction in yield caused by aphids. In further experiments on the effect on aphid build-up of adding derris to the calcium arsenate used throughout the season for boll weevil control, a series of field tests in six representative sections of

the Cotton Belt showed that enough derris added to the calcium arsenate or to mixtures of calcium arsenate and sulfur to make 0.5 percent of rotenone in the final mixtures was effective in preventing aphids from reaching injurious numbers during the period of dusting. Aphid populations were held at lower levels on cotton on the lighter soils of the Southeast than on the heavier, richer soils of the Delta section, and there was some indication that sufficient aphids might develop between the time dusting was discontinued and the crop matured to become injurious under certain conditions. Commercial mixtures of calcium arsenate and derris are being marketed and tested under farm conditions.

Studies of the factors that cause the cotton aphid to increase following the use of calcium arsenate confirmed previous results that factors other than the destruction of parasites and predators were playing a part in their accelerated multiplication. Apparently the calcium or arsenic in the calcium arsenate is absorbed by the leaves or roots of the plants, and one or both of these elements in the leaf fluids on which the aphids feed act as a stimulus on the rate of reproduction. The pH of the cell sap of dusted plants has been found consistently higher than in the controls. Associated with this increase in pH was earlier maturity of the plants and shedding of leaves, greater numbers of aphids born daily, and larger total offspring on the dusted plants. Tests in field plots also established the fact that heavier aphid populations followed the use of calcium arsenates containing higher percentages of water-soluble arsenic.

Studies to ascertain whether commercial calcium arsenate could be improved by the addition of a buffer for the water-soluble arsenic pentoxide, which would reduce the alkalinity and permit the plant to overcome any injury from arsenical, indicated that zinc salts would probably be suitable. As a result of the work on the effect of calcium arsenate on physiological changes in cell sap and increased aphid populations, a new type of calcium arsenate has been produced commercially in which a zinc salt is incorporated in the process of manufacture. It will be tested under field conditions.

ROOT APHIDS

The infestation and damage caused by cotton root aphids were much lower in the spring of 1940 than for the last several years. An experiment in cooperation with the Soil Conservation Service and the South Carolina Agricultural Experiment Station to study the relationship of winter cover crops to subsequent root aphid injury to cotton was conducted on five farms in South Carolina. Cotton was planted following winter plantings of Austrian peas, common vetch, crimson clover, oats, rye, and wheat. Conditions were very unfavorable for the winter growth of these crops, and the dry weather that prevailed during May made counts of the colonies of root aphids difficult and unreliable. Records were made on 69 farms of the abundance of cotton root aphids, as indicated by the colonies of attending ants, in relation to the preceding crop, the winter cover crop, and soil type. These records indicated little relationship between the previous row crop or the preceding winter cover crop and the number of root aphid colonies on cotton, but in view of the unfavorable conditions it is thought advisable not to reach conclusions from this year's results.

HEMIPTEROUS INSECTS

The interest of Arizona growers in the successful results from the use of airplanes for dusting cotton for the control of hemipterous insects, reported last year, has extended to growers in other irrigated sections of the Southwest and resulted in a considerable increase in commercial dusting. A series of tests were conducted in 1940 similar to those conducted in 1939 in cooperation with growers, who furnished the airplane and insecticides. The same insecticide, a mixture of 7½ percent of paris green and 92½ percent of dusting sulfur; the same dosage, 15 pounds of insecticide per acre; and the same time interval, 7 days between applications, were followed as closely as possible. The main difference between the experiments in 1939 and 1940 was in the number of applications. In 1939 a fixed schedule of dusting was followed, and each experimental field in the Salt River Valley received seven applications irrespective of whether the infestation was light or heavy. This gave useful information on the numbers of hemipterous insects required to justify the expense of control, and as a result of the information obtained in this experiment dusting was not begun in 1940 until 12 or more mirids (*Lygus* spp., etc.) or other injurious hemipterous insects were taken per 100 strokes, or 6 or more stinkbugs (*Chlorochroa*, *Euschistus*, etc.) were found by examining 100 plants. When populations in the dusted areas dropped below these numbers, dusting was stopped until the insects again reached the above populations. By following this procedure, from 2 to 7 applications were made between July 10 and August 22 in the different experimental fields. Weather conditions in 1940 were excellent for dusting, and every application was made on schedule. Records of the gin turn-out and of the grade and staple length of the lint from the three fields of short-staple Acala cotton and three fields of long-staple S × P cotton located in the Salt River Valley were obtained for calculating the profits from the dusting operations. The improvement in quality was not so marked in the short-staple as in the long-staple cotton, where increased values of from $2.85 to $30.05 per bale were made in different fields. The seed cotton gained per acre as a result of dusting ranged from 267 to 817 pounds, or an average of 569 pounds, in short-staple cotton, and from 201 to 317 pounds, or an average of 208 pounds, in long-staple cotton. The net profit per acre from dusting ranged from $3 73 to $14.30, or an average of $9, in short-staple fields, and from $6.78 to $13.24, or an average of $9.41, in long-staple fields. The larger gains and greater profits obtained in 1940 than in 1939 indicate that populations of 12 or more injurious hemipterous insects per 100 sweep-net strokes, or 6 or more stinkbugs per 100 plants, is a good criterion for beginning dusting.

BOLLWORM

Since the effectiveness of calcium arsenate against the bollworm is limited by its slow action and the low mortality of the large larvae, cage and field tests were continued with other insecticides. In the cage tests with several insecticides using laboratory-reared larvae divided into four weight groups (approximating the larval instars), the mortalities varied inversely according to the size of the larvae. An average mortality of 92 percent for all weight groups was

obtained with a 1:1 mixture of basic copper arsenate and lime, 88 percent mortality with lead arsenate, 84 percent with undiluted basic copper arsenate, 83 percent with cryolite containing 66 percent of sodium fluoaluminate, and 62 percent with calcium arsenate.

Previous field tests had indicated that heavier dosages of cryolite containing higher percentages of sodium fluoaluminate than had been used in the past were needed for bollworm control on cotton. A series of tests were made in randomized blocks at Waco comparing 16 to 20 pounds per acre of cryolite containing 50, 66, 87, and 95 percent of sodium fluoaluminate with 8 to 10 pounds per acre of calcium arsenate, basic copper arsenate, and lead arsenate. The increases in yield were 51, 124, 163, 179, 144, 155, and 208 pounds of seed cotton per acre, showing an increase in gains with cryolite as the percentage of active ingredient was increased and the largest gain from lead arsenate. In other tests comparing calcium arsenate, lead arsenate, and micronized barium fluosilicate applied as dusts and sprays, the gains averaged about one-third more from the dust treatments than from the sprays.

Field observations have often shown that a heavy deposition of bollworm eggs may fail to develop into a damaging infestation and that bollworm damage is frequently more serious in fields that are heavily infested with aphids. Hot, dry weather is known to be a factor in preventing hatching of the eggs, but studies made this year indicate that predators, including several coccinellids, chrysopids, syrphids, and the anthocorid *Orius insidiosus* (Say), destroyed many bollworm eggs and young larvae. Of particular interest was the observation that under laboratory conditions *Orius* consumed many bollworm eggs daily when other food was scarce, but when aphids were present very few eggs were eaten. As *Orius* was but little affected by dust applications of calcium arsenate containing enough nicotine to destroy the aphids, it seems probable that the addition of nicotine to calcium arsenate used for bollworm control might be of benefit in increasing the effectiveness of this predator.

PINK BOLLWORM

The light infestations of pink bollworms which have been reported in the Big Bend of Texas since 1938 continued in 1940. The periodic examination of 28 representative fields showed approximately the same number of larvae per acre in green bolls at the last examination in 1940 as in 1939. However, fall examinations of crop debris and soil in 27 fields to determine the number of hibernating larvae remaining after the field clean-up showed an average of only 10,454 larvae per acre in 1940 as compared with 15,246 larvae per acre in 1939. A higher percentage of pink bollworms survived in the hibernation cages at Presidio in 1941 than for the last several years. Experiments conducted in cooperation with the Defensa Agricola of Mexico definitely established for the first time that survival occurred in the Juarez Valley.

Although the light infestation was not favorable for extensive tests with insecticides, experiments were continued with the materials that have given the best results in the past. In small-plot tests cryolite containing 33 percent of sodium fluoaluminate caused 31 percent reduction in the number of larvae per boll, cryolite contain-

ing 85 percent of sodium fluoaluminate 53 percent reduction, cryolite-oil spray (50 pounds of cryolite, 50 gallons of light oil, and 50 gallons of water) 60 percent reduction, cuprous cyanide 48 percent reduction, and basic copper arsenate 28 percent reduction. In tests with cryolite having coarse, regular, and very fine particles the coarse particles were inferior in dusting qualities and toxicity to the regular and micronized materials. In cage tests a concentrated barium fluosilicate spray of the type developed for application by autogiro gave about the same control as barium fluosilicate applied as a dust. In laboratory tests to determine the ovicidal effect of nicotine sulfate and light petroleum oil used alone and combined in various proportions with and without emulsifiers, the reductions in hatch ranged from 8 percent to 97 percent. The most effective treatment was a spray composed of 2 pints of 40-percent nicotine sulfate to 50 gallons of miscible oil and 50 gallons of water.

Studies of the factors influencing the formation of hibernating larvae showed that more of the larvae feeding in older bolls entered the resting stage than did larvae feeding in younger bolls. During the period August 2–October 1, 19 percent of the larvae in 20-day-old bolls, 35 percent of those in 30-day-old bolls, and 92 percent of those in 40-day-old bolls were of the long-cycle type. Fewer of the larvae maturing early in the season entered hibernation than of those maturing late in the season, the percentages being 1.7 for the period September 1–15, 31.3 for September 16–30, 54.8 for October 1–15, and 66.8 for October 16–30. Cultural experiments showed that planting of quick-maturing varieties of cotton, close spacing, and the withholding of late irrigations reduced late-season increase in infestation and overwintering populations. These records clearly indicate the value of the early fall destruction of the cotton in the control of this pest.

Another pink bollworm parasite, *Chelonus pectinophorae* Cush., was received from Japan, and 5,000 of these insects were reared and released at Presidio. Liberations of other introduced parasites in the Presidio and Lower Rio Grande Valleys during the year were as follows: *Microbracon nigrorufum* Cush. 3,400, *M. kirkpatricki* Wilk. 10,725, and *Chelonus blackburni* Cam. 160,800.

Biological studies were continued to determine how and where the pink bollworm passes the winter in the Lower Rio Grande Valley of Texas. Breeding occurred in cotton from May 1940 to the freeze in January 1941 that destroyed all squares and bolls. Hibernation experiments showed that pink bollworms will remain in the resting stage in bolls on standing stalks and on the ground from one cotton crop to the next. The maximum duration of the resting stage observed under outdoor conditions in different environments at Brownsville was as follows: In open bolls on standing stalks from September 25 to June 11, or 259 days; in open bolls on the soil surface from September 26 to April 21, or 207 days; in bolls (collected green) on the soil surface from October 28 to May 20, or 196 days; and in bolls (collected green) lightly covered with soil from October 28 to March 17, or 140 days. The heaviest survival also occurred in bolls left on standing stalks, which emphasizes the importance of cutting or plowing under cotton stalks in the fall even though the bolls cannot be destroyed. No larvae have yet been found to pass the winter in free

cocoons in the soil in the Lower Valley, as is the case in the Big Bend and other areas. In bloom examinations during May and June 1941 one pink bollworm was found for each 243,036 blooms examined as compared with one pink bollworm for each 9,088 blooms examined in 1940. This was to be expected as a result of the thorough field clean-up, the maintenance of a closed season for cotton, and the heavy rainfall that occurred during the fall, winter, and spring months, which increased the mortality of hibernating larvae, stimulated early emergence, and delayed the fruiting of the cotton. Light infestations were found in *Malvaviscus drummondi* and in *Pseudoabutilon lozani* during September, October, and November, but in all cases less than 0.5 percent of the pods were infested, and these plants are not considered of economic importance in maintaining the pink bollworm during the closed season for cotton. In addition to the above infestations under natural conditions, *Abutilon berlanderi* became infested from moths confined in cages. Under cage conditions at Presidio pink bollworm larvae overwintering in seed pods of Arizona wild cotton (*Gossypium thurberi*) survived the winter and reinfested the plants the following spring.

PARTICLE SIZE OF INSECTICIDES

Considerable attention was given to determining the effect on the toxicity of insecticides of reducing their particle size. The mean surface diameter of the particles before and after grinding, or micronizing, was determined in the Division of Insecticide Investigations by an air-permeation apparatus. Fine materials, such as calcium arsenate, were but little changed by micronizing, but the particles of paris green were reduced from 11.5 to 0.5 micron surface mean diameter. In cage tests against the boll weevil the original, or unmicronized, samples of calcium arsenates containing low, intermediate, and high water-soluble arsenic seemed to have somewhat better dusting qualities and caused significantly higher weevil mortalities than the micronized samples; however, in field tests using only the calcium arsenate containing intermediate water-soluble arsenic there was no significant difference in yield between the original and micronized material. Mixtures of micronized calcium arsenate and micronized derris, micronized calcium arsenate and unmicronized derris, and unmicronized calcium arsenate and unmicronized derris tested in field plots caused no significant differences between treatments in boll weevil or aphid infestations. Micronized barium and sodium fluosilicates had very poor dusting qualities and were inferior to the original materials in cage tests against the boll weevil. Micronized barium fluosilicate applied as a dust and as a spray also gave less control of the bollworm than the unmicronized dust in plot tests. Micronizing paris green did not increase its effectiveness against the boll weevil when this chemical was used in a dust mixture with lime. However, micronized paris green and dusting sulfur was more effective against *Lygus* spp. and *Chlorochroa* spp. than unmicronized paris green and sulfur. In plot tests a 1:2 mixture of calcium arsenate and micronized sulfur gave better control of the cotton flea hopper than a similar mixture of calcium arsenate and 325-mesh sulfur. Micronized sulfur used as a dust or spray gave about as good flea hopper control as twice the poundage per acre of 325-mesh sulfur dust. Although micronized

424011—42——6

sulfur costs about twice as much as 325-mesh sulfur, it adheres to the plants better, can be dusted under more adverse conditions, and can be used as a spray when the plants are dry.

PINK BOLLWORM CONTROL AND QUARANTINE ENFORCEMENT

The clean-up of more than 400,000 acres of cotton land in the southern Texas regulated area through farmer cooperation was perhaps the outstanding accomplishment for the 1940 season. The intensive field clean-up, together with other repressive measures, put into effect following the harvesting of the 1939 crop, substantially reduced the pink bollworm infestation in this area. There was a further reduction in infestation and increase in per-acre yield in the 1940 cotton crop in the Big Bend area of Texas and Mexico following the application of the special control program in that region for the second consecutive year. Inspection in the Panhandle district showed the lightest infestation since 1935. A special control program put into effect in the east end of the Salt River Valley of Arizona following the harvesting of the 1939 crop apparently eliminated the pink bollworm from the Gilbert section in Maricopa County; however, in the Glendale section in the same county there was some increase in infestation. More than half a million fewer seedling plants were found in southern Florida during the 1940–41 season than during the previous year.

CONTROL PROGRAMS IN THE VARIOUS REGULATED AREAS

LOWER RIO GRANDE VALLEY AND COASTAL BEND DISTRICTS

The control program for the lower Rio Grande Valley and Coastal Bend districts of Texas calls for destruction of the live cotton plants immediately after harvesting, and the maintenance of a host-free condition until the fruiting of the subsequent crop, together with a controlled planting date. The clean-up campaign for the 1940 crop was carried out with the cooperation of the farmers. On October 1, the date fixed by the State for the completion of stalk destruction in the lower Rio Grande Valley, 210,000 of the 220,000 acres in that district had been plowed. Extensions had been granted on approximately 8,000 acres of late-maturing cotton in the northern part of the district, and the remaining acreage consisted of small lots of land owned by nonresidents, on which delays had been occasioned through the changing of tenants or abandonment of the land by tenants. At the end of October the job of stalk destruction had been completed. The second phase of the control program was then begun, which is to prevent the fruiting of sprout cotton, which develops in fields after plowing operations, as well as random stalks growing on abandoned acreage. Despite the splendid cooperation of the farmers and the efforts of inspectors, a completely host-free condition was probably not attained prior to December 15, 1940, as in such a large area, where cotton is in a continuous state of development, it is almost impossible to avoid missing a few plants. It is believed, however, that after October 1 the area was more nearly free from cotton than in any other year except 1939, when payment was made to the farmers for

destruction of the planted cotton. Although weather conditions were unfavorable, this status was maintained until the cotton planted in 1941 reached the general fruiting stage. Cotton matures a little later in the Coastal Bend district than in the lower Valley. Consequently, October 15 was established by the State as the dead line for completion of destruction of the cotton stalks in 1940. Excessive rainfall and the scarcity of pickers greatly hindered the program, and the Commissioner of Agriculture of Texas extended the date to October 31. Owing to continued unfavorable conditions about 14,000 acres of stalks still remained standing at the end of October, but by the end of November most of the acreage had been destroyed.

BIG BEND AREA

For a number of years prior to 1938 the pink bollworm gradually built up in the Big Bend area of Texas and Mexico until about half of the cotton crop was being lost through depredations of this insect. In 1938 a cooperative control program was inaugurated by the Federal and State Departments of Agriculture and the Mexican Department of Agriculture, designed to reduce the heavy infestation in that area. In accordance with this program fields are cleaned as early in the fall as practicable, planting is delayed until April 20, and efforts are made to eliminate all sprout and volunteer cotton until the peak of spring moth emergence is over. In the 1940 crop there was a further reduction in infestation, and for the second season there was little loss to the crop on account of this insect.

ARIZONA

In spite of repressive measures in the Glendale area of the Salt River Valley following the harvesting of the 1939 cotton crop, inspection of gin trash from the 1940 crop showed that there was some increase in infestation. Consequently, arrangements were made to clean approximately 700 acres of land in an effort to control this infestation. Clean-up operations were begun early in January, and under normal conditions would have been completed in 3 weeks; however, owing to the occurrence of floodwaters over a portion of the area and heavy weekly rains, the clean-up was not completed until the latter part of March. On account of this delay only 573 acres were cleaned.

The normal cotton-producing season in Arizona is comparatively long and is substantially lengthened by the practice of growing a cotton crop from the stubs of the previous season. This custom affords an excellent opportunity for pink bollworm infestations to build up. Consequently, a regulation was sponsored by the Agricultural Adjustment Administration and approved by the Secretary which prohibited the growing of stub cotton in Arizona for the 1940 crop. A similar order was approved for the 1941 crop season, but on account of excessive and almost continuous rainfall during the winter and spring months farmers were unable to prepare their land for planting. The same condition caused stub cotton to make favorable growth, and in order that a crop might be produced, the regulation prohibiting the growing of stub cotton was suspended for the 1941 crop season.

QUARANTINE ENFORCEMENT

TREATMENT OF PRODUCTS FOR CERTIFICATION

For the 1940 season 902,794 bales of cotton were produced at the 524 gins located in the pink bollworm regulated areas of Arizona, Texas, and New Mexico. A total of 406,270 tons of seed were sterilized in accordance with State and Federal regulations, and 4,112 bales of lint were roller-treated. A total of 209,531 tons of seed were received and processed at the 48 oil mills located within the area, and 14,868 bales of cotton linters originating in the most heavily infested areas were treated by passing the lint between steel rollers to prevent the escape of pink bollworms. A total of 236 bales of lint and 147 bales of linters were fumigated at the Fabens, Tex., plant in the El Paso Valley district. At the 12 compression plants within the regulated area 576,698 bales of lint and 2,415 bales of linters were compressed.

The supervision of the treatment of cotton and cotton products, to make them eligible for certification for movement into free areas, is one of the most important measures for the control of the pink bollworm.

VEHICULAR INSPECTION

Road stations or patrols are operated on principal highways in certain sections of the regulated area during the periods of greatest movement, to ascertain whether any cotton or cotton products are moving into free areas without certification. Experience has shown that one of the most likely means of dissemination of the pink bollworm is through small lots of seed cotton carried in sacks into free areas by transient cotton pickers. In the lower Rio Grande Valley examination of nearly 28,000 pick sacks during the 1940 season yielded small lots of seed cotton amounting to more than 2,000 pounds, and more than 1,000 pounds were confiscated through the interception of mattresses, pillows, etc. On account of the increase in per-acre yield in the Big Bend area as a result of the great reduction in pink bollworm infestation, only one patrol unit was operated for a comparatively short period, as few pickers left that area to work elsewhere. In the Panhandle district patrols are maintained for the purpose of inspecting seed trucks moving untreated seed to designated oil mills outside of the regulated area, where they are treated as unloaded, and for a short period during the planting season to safeguard the movement of seed.

INSPECTION IN REGULATED AREAS

Inspection of gin trash from the 1940 cotton crop in southern Texas showed that the infestation was considerably lighter than in 1939. In the Brownsville section of Cameron County, where infestation in 1939 was heaviest, there was a remarkable reduction; however, there was an increase in infestation in a small area northwest of this section in Hidalgo County. In the Coastal Bend district no pink bollworms were found in Nueces, Webb, and Zapata Counties, all of which were infested in 1939. In Jim Wells County 1 specimen was found in the 1940 crop as compared with 22 in 1939; however, at El Indio, a small farming section in Maverick County, there was some increase in infestation. In the other southern Texas counties there

seemed to be no significant change. Inspection of gin trash in the Pecos Valley of Texas and New Mexico and the El Paso Valley of Texas showed a decided decrease in infestation. There appeared to be no particular change in the light infestation existing in the Mesilla Valley of New Mexico. There was a further decrease in infestation in the Presidio Valley of the Big Bend; however, at Porvenir, in the upper end of Presidio County, where intensive control measures have not been in effect, a heavy infestation was found in a 30-acre field. Inspection in the Panhandle district showed only 4 of the 20 counties under regulation to be infested, and these to a very light extent. In Arizona there was an increase in infestation in the Glendale area in Maricopa County. In Pima County no pink bollworms were found in the 1940 crop as compared with 2 in 1939. There appeared to be no definite change in infestation in the remainder of the regulated area of Arizona.

A summary of the amount and the various kinds of inspection is given in table 9.

TABLE 9.—*Summary of inspections for the pink bollworm in regulated areas, crop season of 1940*

State	Gin trash		Field				Laboratory [1]	
	Quantity	Pink bollworms	Squares	Blooms	Bolls	Pink bollworms	Green boll samples	Pink bollworms
	Bushels	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
Arizona	12,673	162	0	0	7,350	[2] 10	100	0
New Mexico	2,194	291	0	0	0	0	132	0
Texas	38,348	30,911	1,809	684,916	7,157	[3] 115	109	97
Total	53,215	31,364	1,809	684,916	14,507	125	341	97

[1] Bolls collected from the 1939 crop.
[2] Found through examination of an unrecorded number of bolls on the W. L. Smith farm at Glendale, in Maricopa County.
[3] Of this number 112 came from bolls examined in the lower Rio Grande Valley, and 3 were taken through inspection of a small amount of unrecorded bolls at El Indio, in Maverick County.

INSPECTION OUTSIDE OF REGULATED AREAS

Inspection of gin trash outside of regulated areas is particularly important, as through that means new infestations are established before build-up and dissemination have taken place. Thorough inspection was conducted in the 1940 crop in practically all nonregulated cotton-growing areas in Texas, with negative results. This condition is an improvement over the previous year, when 12 counties were added to the regulated area on account of the spread of infestation. A total of 33,935 bushels of gin trash were inspected in Alabama, Arizona, Arkansas, Florida, Georgia, Louisiana, Mississippi, Missouri, Oklahoma, and South Carolina, and no infestation of the pink bollworm was found. Gin-trash inspection was also conducted in Mexico—in Baja California, Chihuahua, Coahuila, Nuevo León, and Tamaulipas. In the State of Chihuahua 89 bushels of trash were inspected and 35,871 pink bollworms were found. Of this total 35,727 worms were taken in a comparatively small area in the Juarez Valley. A few pink bollworms were taken for the first time at La Ascencion in Chihuahua. In the State of Tamaulipas

there was a substantial decrease in infestation in the Matamoros area, where infestation was heaviest last season; however, there was an increase in infestation in the Reynosa area. An extremely light infestation was found at Nuevo Laredo, Tamaulipas, for the first time in the 1940 crop. At Anahuac in the same State, where the pink bollworm was found for the first time in 1939, there was some increase in infestation.

In the Florida district examination of 54,340 fruiting forms taken from wild cotton plants throughout the area yielded 281 pink bollworms.

A summary of the amount and the results of the various kinds of inspection is given in table 10.

TABLE 10.—*Summary of inspections for the pink bollworm outside regulated areas, crop season of 1940*

State	Gin trash		Field		Field material				Laboratory [1]	
	Quantity	Pink bollworms	Man-days	Pink bollworms	Squares	Blooms	Bolls	Pink bollworms	Green boll samples	Pink bollworms
	Bushels	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
Alabama	9,042	0	0	0	0	0	0	0	0	0
Arizona	20	0	0	0	0	0	0	0	219	0
Arkansas	985	0	0	0	0	0	0	0	0	0
Florida	748	0	36½	0	5,903	1,575	46,862	281	205	0
Georgia	7,714	0	20	0	0	0	0	0	172	0
Louisiana	4,861	0	0	0	0	0	0	0	116	0
Mississippi	3,201	0	0	0	0	0	0	0	114	0
Missouri	26	0	0	0	0	0	0	0	0	0
New Mexico	0	0	0	0	0	0	0	0	86	0
Oklahoma	4,628	0	0	0	0	0	0	0	111	0
South Carolina	2,710	0	0	0	0	0	0	0	0	0
Texas	76,472	[2] 1	0	0	0	0	2,828	0	1,524	0
Total	110,407	1	56½	0	5,903	1,575	49,690	281	2,547	0
Mexico:										
Baja California	568	0	0	0	0	0	0	0	0	0
Chihuahua	89½	35,871	0	0	0	0	0	0	0	0
Coahuila	64	1	0	0	0	0	0	0	163	0
Nuevo León	332	37	0	0	0	0	0	0	61	0
Tamaulipas	1,492	6,194	0	0	528	282,325	293	70	0	0
Total	2,545½	42,103	0	0	528	282,325	293	70	224	0
Grand total	112,952½	42,104	56½	0	6,431	283,900	49,983	351	2,771	0

[1] Covers bolls collected from the 1939 crop.
[2] Probably originated in the regulated area.

WILD-COTTON ERADICATION

Work on wild-cotton eradication in southern Florida was brought to a close at the end of June. Activities for the past season, as for the previous year, were carried on by men furnished by the Work Projects Administration and Civilian Conservation Corps and by regular funds of this Bureau.

For the 1940–41 season work was performed in the Fort Myers-Bradenton subdistrict, the Keys subdistrict, and the Cape Sable area. In all subdistricts there was an exceptional reduction in the number of seedling plants, the total reduction amounting to 641,622 over the previous season. For the first time in the history of wild cotton work it was possible to obtain three clean-ups in the Cape Sable area in one season, this area comprising about 8,000 acres, or

approximately half of the territory involved. The work was greatly accelerated this season, and at the same time more efficiently performed, because all known wild cotton locations had been charted, and hundreds of miles of trails had been cut. Recleaning of wild cotton acreage yielded 26,380 plants with mature fruit, 684,865 seedlings, and 1,117 sprout plants. As the result of scouting done outside of known locations, 84½ acres were added to the known cotton acreage and 4,444 virgin plants and 5,657 seedlings were destroyed.

During the last 3 weeks of June a campaign was conducted to locate and remove dooryard cotton plants in Dade and Broward Counties. In Dade County plants found on 222 premises yielded 623 mature and 1,157 seedling plants. In Broward County 170 mature plants and 166 seedlings were taken from 80 premises. A very light infestation was found in fruiting material taken from these plants.

COOPERATIVE WORK WITH MEXICO

Pink bollworm infestation exists in practically all cotton-growing areas along the international boundary from the Brownsville-Matamoros area in southern Texas and Mexico to and including Arizona. On account of the apparent ability of this insect to spread long distances by means of moth flight and wind carriage, the Rio Grande, which forms the international boundary line between Texas and Mexico, offers no obstacle to the movement of the insect. Consequently, it can readily be seen that full cooperation of agricultural officials of Mexico and the United States is of paramount importance for control. Mexico has recognized the advantages to both countries through the control of this pest, and definite, although informal, cooperative plans are in effect in practically all infested areas. In addition to the usual sanitary measures, such as sterilization of seed, cleaning of concentration points at gins, etc., cooperative field clean-up programs, supplemented by control of planting date, were carried out in the lower Rio Grande Valley and the Big Bend of Texas and Mexico during the 1940 crop season. A clean-up campaign was also conducted by the Mexican Department of Agriculture in the Juarez Valley of Mexico at a heavily infested point opposite McNary, Tex., in the El Paso Valley. The United States Department of Agriculture cooperated through the loan of technical assistance in perfecting and executing the clean-up program. No control measures had previously been applied in that area. The Mexican Government appropriated funds for the destruction of stub or volunteer cotton at Anahuac, in the State of Tamaulipas, on approximately 1,200 acres of abandoned cotton land in the 60,000-acre Don Martin irrigation project, and this undertaking was completed the latter part of June. Technical assistance was also given by the Bureau in connection with this undertaking.

THURBERIA WEEVIL CONTROL

Areas under quarantine in Arizona on account of the Thurberia weevil are also under pink bollworm quarantine. As the regulations governing the treatment and movement of all products under both quarantines are similar, the entire area is treated much as

though only one quarantine were applicable, although in any instance of dissimilarity in the regulations the one requiring the greater precaution is invoked.

Inspection of material from the 1940 cotton crop indicated that only an extremely light infestation existed in the areas under regulation. Thurberia weevil infestation has been consistently light in domestic cotton since the inauguration of the quarantine, and has resulted in no commercial damage to the crop. The regulatory measures in effect seem to be giving adequate protection against the spread of this insect.

BEE CULTURE

The maintenance of an active and healthy beekeeping industry is an important defense measure if American agriculture is to function to the fullest extent in the present crisis. The honeybee's importance as an indispensable aid to agriculture through its pollination activities is even greater than its value in honey production. In this respect honeybees can be considered as an agricultural catalyzer, for numerous plants would fail to be perpetuated and many fruit and forage crops could not be grown successfully without bees to fertilize the blossoms. In recent work of the Bureau it was found that during the active season a colony gathered more than 71 pounds of pollen. Such an amount requires the visitation of millions of flowers, and further millions must be visited to produce a crop of honey, for pollen and nectar are usually obtained from different blossoms, and a single blossom seldom secretes more than a mere fraction of a drop of nectar.

In the work on the resistance of honeybees to American foulbrood, carried on cooperatively with the States of Arkansas, Iowa, Texas, Wisconsin, and Wyoming, 232 queens were distributed to agricultural agencies in 34 States. The various lines of stock under test showed less resistance in 1940 than in 1939, and this may have been due to a decreased honey flow. The prospects are bright that the use of resistant strains will help not only to control American foulbrood but eventually to eradicate it.

Inoculation of individual larvae 1 day old or younger with spores of the causative organism of American foulbrood resulted in the infection of about 41 percent of those sealed, but less than 5 percent of those inoculated in the second day of larval life showed infection. Worker bees removed, before time for sealing, about 32 percent of the larvae inoculated on the first day of larval life, 4 percent of those inoculated on the second day, and 3 percent of those inoculated on the third and fourth days. One spore is apparently sufficient to cause infection, although consistent infection of all larvae was not produced even by larger inoculations. Infection depends on the age of the larvae, rather than on the number of spores or on resistance in the larvae, for brood from resistant colonies became infected as readily as that from susceptible colonies. The studies continue to show, even more conclusively than in the past, that resistance to American foulbrood is not a physiological characteristic but a matter of the behavior of the adult bees.

Carmine, starch, and ferric oxide proved unsuitable as tracers for determining when honey is first fed to larvae. Stained *Aspergillus*

spores were tried, but during the storage of the sirup the number of spores became too greatly reduced. This reduction, however, demonstrates a behavior that may be of vital importance in the transmission of American foulbrood if a similar reduction occurs when the bees ingest disease spores.

Nosema disease may be more responsible than heretofore indicated for loss of queens, poor brood production, and unfavorable wintering. Several queens that had stopped laying were found to be heavily infected with *Nosema apis*. Examination of a number of overwintered colonies showed this organism present in 15 percent of them. The infected colonies survived in poor condition.

Investigations on the heavy losses of adult bees in Utah, conducted in cooperation with the Utah Agricultural Experiment Station, gave little evidence that grasshopper bait is responsible.

Honeybee eggs exposed to sunlight for 5 to 7 minutes were practically all killed, whereas the mortality of larvae 2 to 3 days old exposed to sunlight for 10 minutes was negligible. Exchanging combs of eggs between 2 colonies appeared to have no effect on subsequent brood mortality.

The death rate and food consumption of bees bore no significant relation to the quantity of pollen reserve in two colonies with abundant pollen reserves, two colonies with negligible pollen reserves, and one colony with sugar-sirup stores only. Recently consumed pollen was found in the midintestine of some bees throughout the winter. Wax scales were dropped to the bottom boards in all colonies wintered outdoors and also by the bees caged more than 2 months; wax is therefore secreted by old bees, even in the absence of comb-building activity. In cage tests begun March 17, and conducted in a constant-temperature room at about 93° F. and 22 percent relative humidity, bees from a colony fed sugar sirup lived 61 and 65 days in duplicate cages, or more than a week longer than the average for bees from colonies wintered with abundant pollen reserves.

Progeny from 15 breeder queens, representing 6 lines of stock, that were tested for honey production showed greater variability among lines of stock than among individuals within a single line. Average yields for the test groups ranged from 83 to 205 pounds, while individual colony yields ranged from 8 to 318 pounds. Differences were also found in the amount of brood produced, the percentage of queens superseded, and the strength of the surviving populations at the close of the active season. Lines of stock showing either high or low performance in 1 season held their same relative position during succeeding years.

Progress is being made in breeding a strain of Italian bees of distinctive color. Since it is difficult to distinguish even between races of the honeybee, lack of strains with well-marked physical characters has been an important deterrent of strain improvement. Because of the ease with which it can be identified, this new strain should prove of value as foundation stock in which to incorporate disease resistance, honey-gathering ability, and other desirable qualities.

Approximately 7 million sperms have been introduced into the spermatheca of a queen bee by artificial insemination, which is about 1 million in excess of the number in naturally mated queens. Since mature drones contain about 10 million sperms, once the technique

has been perfected it may be possible through artificial insemination to have queens head colonies for a longer period than when they mate naturally.

Chemical analyses of pollen from 34 species of plants indicate that, in addition to being rich in minerals, pollen also has a valuable vitamin content. The fat content of pollen ranges from about 1 to 14 percent. Pollen shells are hard and resistant to chemical action, and have been found in coal, peat bogs, and ocean slime; they may therefore have characteristics of possible value for plastics or fabrics.

Feeding experiments with pollen added to sugar sirup suggest that there are two phases of pollen feeding. Egg laying is stimulated by pollen in the liquid food supplied the queen by the worker bees, and brood rearing is dependent on the pollen reserve in the form of bee bread. Egg laying, however, seems to be the reaction to pollen eaten, not by the queen, but by the workers, since the stomach of a queen contains few or no pollen grains. Her nitrogenous food is obtained from the worker bee as a secretion, but its gland source remains a mystery.

Correlation of the fat content of pollen with bee activity indicates that the higher egg-laying levels are reached when bees are working plants having pollen high in fat content, such as mustard and dandelion.

Two alfalfa plants, blossoming under artificial lights, which had shown a difference of 24 percent in the sugar concentration of their nectars last year, were tested again this year. When the plants were on dry soil the difference in sugar concentration was 17 percent, and when on wet soil 26 percent. The difference in the sugar content of the nectar of these plants thus appears to be a constant characteristic. Such differences between plants have significance from a breeding standpoint if proved to be hereditary.

Hand-collected nectar held at room temperature in the laboratory for a year out of contact with bees was found to have its sugars inverted, while sugar (sucrose) solutions held under the same conditions remained unchanged. It has been commonly supposed that the honeybee brings about a change to reducing sugars by adding invertase to nectar, but apparently this change may take place in nectar that has had no contact with bees. The degree of change, however, varies with the kind of nectar. Thus, orange nectar was found to be high in reducing sugars when first gathered but showed little or no change when held for a year at 20° F. and also at 36°. In contrast to the orange, poinsettia nectar was higher in sucrose when first gathered, and showed marked change after being kept at 36° for 5 months.

Under a humidifier an Acala cotton plant yielded involucre nectar in quantity, each gland yielding 54 microliters. The sugar content was 17 to 24 percent. A floral nectary of this plant yielded much less nectar with a sugar content of but 7 percent, whereas its leaf-gland nectar contained 12 percent of sugar. Unlike the vetch and acacia, the extrafloral nectaries did not yield until after the flowers appeared. Cotton plants observed at Davis, Calif., yielded insufficient nectar to attract bees.

The value of bees in the pollination of alfalfa has been questioned because they do not trip the alfalfa blossoms. It is of interest,

therefore, that bee-trapped pollen in the Imperial and Salt River Valleys in California showed large quantities of alfalfa pollen, whereas this pollen was not found in traps in other parts of California, the Rogue River Valley of Oregon, or Nevada.

INVESTIGATIONS OF INSECTS AFFECTING MAN AND ANIMALS

MOSQUITOES

In a search for new larvicides for mosquito control, 121 organic compounds and 8 inorganic materials were tested on laboratory cultures of the southern house mosquito. Of these a new azo compound and an isothiocyanate were more promising than phenothiazine, the mosquito larvicide most recently developed. To avoid needless expenditures for ditching marsh or swamp areas, an effort is being made to determine the potential mosquito production of different areas by collecting sod samples and flooding them to hatch the eggs that may be present. This method appears to have practical possibilities and may result in reducing the cost of control operations as well as making them more effective.

During the year members of the Division have assisted several defense agencies by making mosquito surveys in the vicinity of military camps on the Atlantic seaboard and the Gulf coast, and by furnishing working plans and estimates covering mosquito-control programs.

In an area where heart worms of dogs are a local problem, it was learned that the salt-marsh mosquito *Aedes taeniorhynchus* (Wied.) served as a transmitting agent.

In the Pacific Northwest definite information was obtained that a reduction in the oxygen content of water is the main stimulating factor in the hatching of *Aedes* eggs. Already the knowledge has been put to good use from an experimental standpoint, in that mosquito eggs contained in sod and soil samples in nature, and normally requiring several months to complete development, can now be made to hatch regardless of their age or the season of the year. Mosquito-control surveys and population studies are therefore greatly aided by this improved technique. This investigation on hatching stimuli is complete, but it has presented an explanation of an important point in mosquito biology and has suggested a new approach to control. Studies on the biology of mosquitoes in the Pacific Northwest showed that eggs of *Aedes vexans* Meig. and *A. lateralis* (Meig.) would remain viable in the soil for at least 7 years, although after 5 years less than 1 percent as many eggs hatched as previously.

SAND FLIES

In cooperation with the Saint Lucie County Sanitary District of Florida it has been found that sand fly breeding can be controlled by diking a large acreage of mangrove and pickleweed marsh. Experiments showed that both larval and adult populations were reduced 90 percent in diked marshes.

TICKS AFFECTING MAN

Evidence was obtained that populations of the American dog tick, carrier of the dread Rocky Mountain spotted fever of man, can be

consistently though slowly reduced in a heavily infested area by systematically dipping all dogs, the favorite host of adult ticks, and poisoning meadow mice, the favorite host of nymphs.

CLEAR LAKE GNAT

Investigations on the Clear Lake gnat have progressed to the point where three promising lines of attack have been developed: (1) Operation of specially designed electric-light suction traps, which attract and destroy up to 85 pounds of gnats (about 85 million) in one night; (2) destruction of egg drifts on the water by specially devised means of burning with gasoline; and (3) use of a screen of fire produced by burning gasoline across the path of the gnats during their shoreward flights. The next step is to prove the efficacy of these methods on a large scale. Studies on the biology of the pest have yielded valuable information on seasonal abundance, food requirements, and habits. The total annual production of adults in this one lake is estimated to be from 250 to 350 tons.

SECRETIONS OF INSECTS

A new healing agent for purulent wounds, ammonium allantoinate, has been discovered in the secretions of fly maggots, and a public-service patent has been asked for this agent. Another healing agent discovered in the secretions of fly maggots, coded as extract K, is valuable for treating osteomyelitis, one of the most serious complications that follow war wounds. Both extracts have been tested by a number of collaborating physicians. Eighty medical products, originally discovered in the secretions of insects, are now prepared synthetically by 25 companies, with an annual sale of over a million dollars. About 200,000 cases of nonhealing wounds have been treated with these compounds in the United States since their discovery under this project.

HOUSEHOLD INSECTS

With the small sum available it has been possible to do little more than attempt to meet requests for information with the often meager facts at hand. A new mothproofing agent has been discovered, and an application has been made for a public-service patent on this chemical. During the year part of the time on this project has been given over to service work, particularly for defense agencies where large stocks of raw wool, blankets, and stored foods have been concentrated. Building and commodity fumigation technique has been demonstrated also at cantonments for the benefit of the military agencies. Samples of commodities have been tested for the United States Maritime Commission, the Federal Trade Commission, the Air Corps and the Quartermaster Corps of the United States Army, and the Marine Corps of the United States Navy to determine their mothproofing qualities.

SCREWWORMS

Outstanding progress was made in this field during the year. Of some 200 mixtures prepared and tested under both laboratory and field conditions, 12 proved to be superior to any remedies heretofore developed for the treatment or prevention of screwworm infestations

in domestic animals. One of these, known as formula 62, was better than the others from the standpoint of practicability, availability of its ingredients, cost, average performance in the treatment of severe cases, and protective value to wounds to prevent infestation. Formula 62 is composed of diphenylamine (technical) 35 percent, benzol (90 percent commercial) 35 percent, turkey red oil (pH 7 or 10) 10 percent, and lampblack (Germantown) 20 percent. It is effective against all species of fly larvae normally infesting wounds of animals, even under the most difficult conditions. This formula with modifications has also proved of value in the treatment of fleece-worm cases. The development of formula 62 has placed in the hands of farmers and ranchmen in screwworm-infested areas an effective weapon in combating one of the most destructive insect pests of livestock.

Data collected over several years on the biology and ecological relationships of the primary screwworm have shown that natural factors have a tremendous influence on the propagation of this pest. The fly breeds only in the tissues of warm-blooded animals, and most of the trouble from screwworms develops as a result of wound-producing and breeding practices on domestic livestock. It should be possible in Texas and adjoining States to prevent infestations and practically eradicate screwworms by coordinating certain ranch practices with seasonal and climatic factors which tend to destroy the insect. A program based on this method of controlling screwworms, together with data obtained from fly-trap collections, was initiated in Texas by the State Extension Service, the State Experiment Station, and various livestock organizations. The educational work, carried on mainly by extension agencies, consists in making available to livestock owners information concerning the timing of surgical operations on their animals and the dropping of young to prevent such practices from providing a breeding medium for the flies during periods when natural factors are also operating to destroy them.

The loss by fire of the office building and its records at the Menard, Tex., laboratory has severely handicapped all lines of research projected on screwworm control. This handicap is particularly unfortunate because of the importance of the livestock industry to national defense.

CATTLE GRUBS

Demand in connection with defense activities for increased production of certain dairy products and for leather free from serious damage, such as that caused by the cattle grub, has stimulated stockmen in many States to undertake its control. Investigations have yielded a less expensive method of controlling this 50-million-dollar pest of American cattle in the substitution of wettable sulfur for soap in the cube wash previously recommended. Since water is not objectionable when wettable sulfur is used, the need for soft, hot water to dissolve the soap is eliminated without increase in cost. Another achievement is the development of a dust composed of equal parts of cube powder (5 percent rotenone) and wettable sulfur which can be applied with a shaker or dusting can. This type of treatment is not only simpler than a wash, but more economical in treating small herds and more satisfactory in cold weather.

FLY SPRAYS

A method was developed whereby accurate comparative assays of toxic or repellent materials can be obtained. Of the toxic materials studied, pyrethrins and rotenone were found the most effective in controlling stable and horn flies. It was demonstrated that only a few of these flies are able to feed on an animal treated with a pyrethrin or rotenone spray before they are killed. This toxic action was observed to persist almost undiminished for at least 7 hours after spraying.

TICKS AFFECTING ANIMALS

The investigations on the control of the brown winter tick consisted primarily in a search for an insecticide that would kill all stages of the tick and protect horses against reinfestation when applied as a wash. A light mineral oil meets these requirements, but has some features which make its general use undesirable for the control of this tick. Research is going forward, however, for a more suitable insecticide, as well as for other methods of control. Knowledge has been gained on an effective material that can be incorporated with a number of nondrying adhesives for application to the ears of range animals to prevent attachment of the Gulf coast tick. Field tests on several hundred animals demonstrated that topical applications of such mixtures do not injure the skin and that one of them retained its toxicity for as long as 10 months. The applications usually protected animals from infestation for about 4 weeks, during which time the ticks that walked over the treated ears were killed.

HORN FLY INVESTIGATIONS

Biological studies demonstrated that horn flies feed twice daily and consume an average of 1.71 milligrams of blood per feeding. On this basis the loss of blood from a heavily infested herd of 500 animals on a ranch at Cresson, Tex., where estimates of horn fly populations were made throughout the year, was calculated to be 7 quarts per day, or 312 gallons per year—a substantial loss indeed to the cattle industry. The larval period was found to be approximately 4 days and the pupal period 5 days. Two common, inexpensive chemicals not heretofore considered to be insecticides, zinc oxide and zinc stearate, were found to inhibit the development of horn fly larvae in the droppings of cattle to which these materials had been fed. One feeding a day with 1.5 grams of zinc oxide per hundredweight of animal, costing about two-thirds of a cent per head for average-size dairy cows, gave excellent results and caused no ill effects in animals treated for 30 days. Public-service patents have been requested for the two medicants described.

LICE, MITES, AND HEAD BOTS

Investigations have shown that a number of organic chemicals can be emulsified and made into practical dips for the rapid destruction of both lice and their eggs when infesting animals in long fleece. The perfecting of a dip that will kill the eggs of lice is a distinct advance over nonovicidal insecticides now used in goat louse control, which require several dippings annually to effect complete eradication. It was also found that the maximum incubation period of the eggs of the short-nosed cattle louse is much longer than the minimum develop-

mental period of the larvae. Consequently, this louse cannot be eradicated by two treatments with the cube-sulfur dip no matter how the dippings are spaced. Preliminary field tests have demonstrated that cattle lice can be controlled by applying the cube-sulfur dip with either hand- or power-operated sprayers. This method of treatment is useful and economical for treating small herds and is satisfactory for treating large herds where dipping vats are too expensive or are not available.

DOG FLIES

Along the coast of northwestern Florida extensive breeding of the stablefly, or dog fly, was discovered in tidal drifts of bay grasses on the beaches of inner bays and sounds. These drifts of green grass ferment and furnish an excellent medium for the deposition of countless numbers of dog fly eggs. These eggs are capable of developing into flies within 13 days. Creosote oil diluted with 3 parts of Diesel oil will kill the larvae if it is applied with a high-pressure sprayer. Another breeding place of dog flies was discovered in fermenting peanut litter left in the fields after the peanuts had been picked and the vines baled for hay. It is recommended that this litter be scattered and plowed under immediately after harvest. A third and very different breeding medium was found in celery strippings which are dumped in large piles adjacent to celery-washing establishments. Extensive surveys have been made for controlling the dog fly both within and without military reservations, and detailed estimates have been prepared at the request of defense agencies, the Work Projects Administration, and the State of Florida.

INSECT IDENTIFICATION

Identifications made and reported totaled 60,461 for 26,580 lots involving 340,000 specimens. Of these identifications 39.9 percent applied to interceptions by the Division of Foreign Plant Quarantines; 25.4 percent were for other activities of the Bureau and various Federal agencies; 18.8 percent for agricultural colleges, experiment stations, and other offices of the States and insular possessions; 11.4 percent for individuals, private agencies, and pest-control operators in the United States; and 4.5 percent for foreign institutions and agencies, principally in the Western Hemisphere. Of the total number of identifications 66.8 percent were definite and complete, but the figures for the various insect groups differed widely, ranging from 39 percent for the mites to 90 percent for the aphids. Lots remaining unfinished at the end of the fiscal year totaled 1,860.

Ninety manuscripts originating outside the Division were reviewed, this work involving verification or correction of approximately 30,000 scientific names.

Maintenance and improvement of the extensive reference collections that are essential to identification work were continued, and 106 exchanges and study loans, involving 15,210 selected specimens, were arranged. Approximately 105,000 specimens, nearly 40 percent of which were from Central and South America and the West Indies, were added to the collections, mostly from material received for identification.

Results of research conducted in the Division were presented in 44 manuscripts completed and submitted for publication. They totaled 2,513 manuscript pages and involved the preparation of 1,432 illustrations. Included were certain large papers on which work had been in progress for several years. The more important of these were a classification of the fruitflies of the genus *Anastrepha*, a comprehensive study of the North American flatheaded borers of the tribe Chrysobothrini, a monographic treatment of the blowflies of North America, a catalog of the types of the genera of bees, and a critical morphological study of the genitalia of the Hymenoptera fundamental to taxonomic work in this order.

FOREIGN PARASITE INTRODUCTION

The foreign investigations on the natural enemies of crop pests were continued throughout the year at the field stations at Yokohama, Japan, and Montevideo, Uruguay, and the imported material was received and passed through quarantine at the Hoboken, N. J., receiving station. A total of 41 lots of parasite material were received at that station from foreign stations, and 40 consignments were forwarded to domestic Bureau and cooperating stations.

PARASITES OF CEREAL AND FORAGE INSECTS

An extended survey of the white-fringed beetle was made in the temperate sections of Chile, this supplementing the earlier survey in Argentina, Uruguay, and Brazil. In some localities this insect was found to be a serious pest of potatoes, both in the field and in storage. Detailed data were obtained upon its distribution, food plants, life history, and climatic range. No natural enemies were encountered.

Additional small shipments of the Sao Paulo strain of the Amazon fly (*Metagonistylum minense* Towns.) were made to Puerto Rico and the United States, and a total of 2,531 puparia of *Theresia claripalpis* V. d. W. were sent to Puerto Rico.

By arrangement with the Division of Cereal and Forage Insect Investigations the rearing of *Triaspis thoracicus* (Curt.), a vetch bruchid parasite, was continued through the 1941 season at the Hoboken station. A total of 9,250 adults were reared and forwarded to field stations in North Carolina and Oregon. The work with this parasite is now completed, as it has been liberated each year since 1935 against the pea weevil and since 1937 against the vetch bruchid.

PARASITES OF FRUIT INSECTS

The principal activities of the year centered around the rearing and importation of parasites of the Comstock mealybug (*Pseudococcus comstocki* Kuw.) from Japan. Shipments consisted of 500,000 larvae of *Allotropa* No. 1 and 20,300 larvae of 3 other species of *Allotropa*, 3,095 adults and 1,989 larvae of *Leptomastix* sp., 2,500 larvae of *Pseudaphycus* sp., and 42 adults and 731 larvae of *Anagyrus* sp. All the immature material was reared under quarantine conditions to eliminate secondary parasites.

Additional data were obtained regarding the alternate hosts of *Inareolata molestae* Uch., the most effective parasite of the oriental fruit moth in Japan. The most important of these are *Anacampsis*

metagramma Meyrick on peach and other fruit trees and two leaf tiers, *Olethreutes* sp., on willow and a species of the same genus on *Elaeagnus* sp.

PARASITES OF TRUCK-CROP INSECTS

Two consignments of *Lydinolydella metallica* Towns., consisting of 2,533 puparia, were imported from Brazil during June, largely for experimental studies on its hibernation habits. This parasite attacks the Mexican bean beetle, and its method of hibernation will determine whether it can be successfully established in the United States. Preliminary surveys were made to ascertain the status and natural enemies of the vegetable weevil and the pea weevil.

PARASITES OF COTTON INSECTS

Activities in South America have been directed mainly toward securing parasites of the pink bollworm, the boll weevil, and the cotton stainer. Shipments of bollworm parasites consisted of 142 larvae of *Calliephialtes dimorphus* Cush. from Brazil and final consignments totaling 587 *Chelonus pectinophorae* Cush. from Japan. Six shipments, comprising 3,725 adults of *Microbracon vestiticida* Vier., a boll weevil parasite, were made from Peru direct to Texas by air mail, with a survival of 86.4 percent. A small consignment of several species of tachinid parasites of cotton stainers was sent to Puerto Rico for testing against genera that occur in that island and the United States.

EFFECT OF CHEMICAL CONTROL METHODS ON POPULATIONS OF NATURAL ENEMIES

Investigations on the scale insects and red mites of citrus have continued at the Whittier, Calif., station. The staff of the Hoboken, N. J., station completed its study of the codling moth in West Virginia and then centered its activities upon the white apple leafhopper and the European red mite.

Experiments on citrus pests revealed that cyanide concentrations under field tents are uniform at all levels from the ground; consequently no increase in survival results from the habit of certain predators of dropping to the ground when the gas is first released. Application of sulfur dust caused a 90-percent reduction of *Comperiella* adults on the trees within 24 hours after treatment. Tartar emetic deposits upon foliage remained extremely toxic to adult parasites even 2 weeks after application. The dusting of trees with cryolite resulted in a high mortality of *Cryptolaemus* beetles; therefore, mealybug infestations cannot be satisfactorily controlled by liberation of this predator if the trees are treated with this material. Sprays that leave a granular residue, even of inert material, induce an abnormal increase in red mite populations comparable with that found to occur with the purple scale in Florida; the use of such sprays consequently should be discontinued in favor of others that leave no granular residue.

In studies on the status of *Comperiella* as a parasite of the yellow scale, it was found that high efficiency is associated with a low host density, which is contrary to experience with other species. This parasite therefore is unlikely to be effective in reducing heavy infes-

tations but will hold the pest at a low level after it has been reduced by other control measures.

The completed studies on the codling moth in West Virginia, in which all cover sprays were omitted from the biological-control orchard, showed a 50-percent production of such fruit over a 3-year period as compared with 72 percent in the commercial orchard that received the full spray schedule. It was not possible to determine accurately the relative value of the different natural control factors, though the population of parasites remained consistently low, whereas the predators, particularly ants, were more abundant in the untreated orchard. The results indicate that, in some sections and under certain conditions, the discontinuation of spraying against this pest gives a net return to the grower approximately equal to that obtained after application of the standard spray program, and is particularly applicable to home orchards.

COOPERATION WITH STATE, TERRITORIAL, AND FOREIGN ORGANIZATIONS

Active cooperation with the Puerto Rico Agricultural Experiment Station continued during the year. Shipments of two parasites of the sugarcane borer were made to that station from South America and, after rearing, a portion of the material was forwarded to the United States. Two parasites of plant bugs were also shipped to Puerto Rico from Chile for testing to determine their suitability against pests occurring in that island and the United States. One consignment of parasites of the green scale on coffee was forwarded from Brazil by the Division's station at Montevideo.

During the year the Division has cooperated with the Citrus Experiment Station of the University of California in the importation of parasites of the California red scale from southern China. As a precaution against certain citrus diseases the imported material, consisting of infested citrus twigs, was received at the Hoboken, N. J., receiving station rather than in California, and was handled under strict quarantine conditions. Twelve shipments were received via air express from Hong Kong. The parasites, upon emergence, were transferred to infested grapefruit from California, and this stock was then shipped to the Citrus Experiment Station.

Assistance was rendered to the Connecticut Agricultural Experiment Station in the importation of several hundred thousand *Trichogramma japonicum* Ashm. from Japan for experimental purposes.

Shipments of parasites and predators have been made to official agencies in foreign countries as follows: *Prospaltella berlesei* How. to Cuba for liberation against the white peach scale, *Rodolia cardinalis* Muls. to Ecuador and Venezuela against the cottony-cushion scale, and *Aphelinus mali* Hald. to Ecuador and Venezuela against the woolly apple aphid.

CONTROL INVESTIGATIONS

TESTING INSECTICIDES

Work was continued on the testing of new insecticidal materials to replace those which may be injurious to consumers when sprayed on the edible portions of plants, or to take the place of those not avail-

able because basic materials are needed for defense purposes or difficult or impossible to obtain because they are of foreign origin.

Approximately 2,500 tests were made on 200 or more synthetic compounds as stomach poisons to leaf-feeding insects. Eighty-eight of these compounds were tested for the first time. In these tests 14 species of insects and 5 species of plants were used. Of the 1,500 synthetic compounds tested to date 30 have shown considerable toxicity to 2 or more species of insects and are being intensively investigated.

Phthalonitrile, 1,4-diphenyl semicarbazide, p-aminoacetanilide, and p-aminoazobenzene hydrochloride have been found effective against a number of leaf-feeding insects and to be tolerated in insecticidal quantities by a number of crop plants. Sufficient data have been obtained on these four materials to warrant recommending them for preliminary testing against various crop insects on field plots.

Four more compiled reports of tests of the insecticidal properties of organic materials were prepared and issued. The complete series gives data on over 11,000 tests on insects, using 1,500 different materials.

Tests of 116 synthetic organic compounds as insecticidal aerosols indicate that pentachlorophenyl, 3,5-dinitro-o-cresol, phthalonitrile, and 3-chloroacenaphthene were among the most toxic. The addition of a small quantity of oleic or lauric acid to the aerosols greatly improved the suspension of the particles in air and increased their insecticidal property.

Tests on greenhouse insect pests indicate that nicotine and possibly other insecticides, when applied in combination with oleic acid or other wetting agents, may be effective when dispersed as aerosols under greenhouse conditions.

The use of dichlorodifluoromethane, a gas at ordinary temperatures, as a carrier and dispersing agent for insecticidal aerosols of pyrethrum and other toxic agents showed considerable promise in the control of adult mosquitoes under laboratory conditions.

In an effort to develop commercial strains of pyrethrum and rotenone-bearing plants to establish a domestic supply of these materials, 70 of the more promising pyrethrum plants and 118 samples of rotenone-bearing roots were tested in cooperation with the Bureau of Plant Industry.

Kerosene solutions rich in pyrethrin II caused a rapid knockdown of American cockroaches, and solutions rich in pyrethrin I at lower concentrations caused higher mortalities, but at higher concentrations the mortalities with the two solutions were about the same. Female roaches are about twice as resistant to pyrethrum as male roaches.

In a study of activators for pyrethrum it was shown that the addition of 1 percent of sesame oil in solution increased the effectiveness of pyrethrins against houseflies and some other household insects about three times. Inasmuch as pyrethrum flowers cost 24 cents a pound and about 12 million pounds are imported each year, the combination has excellent commercial possibilities.

FUMIGATION INVESTIGATIONS

In a continuation of the work on treatments for nursery stock in the area regulated by the Japanese beetle quarantine, three new

methyl bromide fumigation schedules were developed. These schedules, with the four formerly approved, make unnecessary the heating of plants at temperatures between 50° and 73° F. and greatly facilitate the application of the treatment. Investigational work also showed that the size of the soil mass on balled and burlaped plants could be increased to 14 inches in least diameter without increasing the survival of the immature stages of the insect in any of the fumigation treatments authorized. During the year approximately 1,350,000 plants were fumigated with methyl bromide for shipment from the regulated area at a cost of about $25,000 less than would have been the case if the lead arsenate treatment had been applied.

Studies were continued on the tolerance of plants to methyl bromide under the conditions necessary to produce complete mortality of the immature stages of the Japanese beetle. Tests of 986 varieties of dormant perennials showed only a few to be injured by the treatment. In a survey of the results obtained by nurserymen in the commercial fumigation of 2,024 varieties of plants, mostly in soil, 9.6 percent of the varieties were reported damaged after fumigation.

Investigation of certain coniferous evergreens on which methyl bromide injury was reported indicates that injury is closely associated with the physiological condition of the plant, the plant being much more resistant when entirely dormant than just prior to the start of growth. Work is being continued in developing other treatments for application to varieties which are injured by the approved fumigation schedules.

The work on methyl bromide fumigation of deciduous-fruit nursery stock for the oriental fruit moth was confined mainly to a study of the comparative effect on early-winter and mid-winter fumigation. No injury was evident from treatments at either period, and it was shown that the stock could be fumigated and stored without damage. Shipments of fruit stocks fumigated for the oriental fruit moth to the Western States totaled more than $100,000 in value in the past year.

Two methods were developed for the treatment of soil plots for the white-fringed beetle and are available for use in the eradication of localized infestations of this insect. In one treatment methyl bromide is used, and in the other carbon disulfide. Complete kill of the insect at a depth of 24 inches in undisturbed soil can be obtained with these treatments.

Two treatments for balled and burlaped nursery stock to control the white-fringed beetle were developed during the year. One consists in fumigation with methyl bromide under reduced pressures (vacuum fumigation) for plants in soil masses up to 11 inches in least diameter; the other comprises treatment of soil masses up to 7 inches in diameter with a solution of methyl bromide in alcohol and water. These treatments facilitate the movement of nursery stock from the regulated area without danger of disseminating the insect.

In checking the work on the fumigation of potatoes for the potato tuber worm under eastern conditions, it was found that the eggs, larvae, and pupae were killed with a dosage of 2 pounds of methyl bromide per 1,000 cubic feet for a period of 2 hours, but that the larvae within the potatoes required a longer exposure at a slightly higher dosage. These experiments were carried out at 80° F.

In a continuation of the experiments on vetch seed, in which tests were made at an exposure of 24 hours at temperatures above 80° F., it was found that a dosage of 1 pound of methyl bromide per 1,000 cubic feet was sufficient to obtain a complete mortality of this insect in vetch seed at a maximum load of seed of 12,900 pounds per 1,000 cubic feet.

Methods of fumigation of sweetpotato plants for the sweetpotato weevil were put on a commercial basis in the last 2 years. A method for fumigation with methyl bromide was developed which can be applied in a fumigation chamber costing about $8, at a cost of less than 2 cents for the fumigant for 8,000 plants, or enough plants for approximately 1 acre.

In the development of treatments for imported plant products, data on lethal dosages of methyl bromide for 15 additional foreign insects were obtained, as well as considerable additional data on several previously studied. A number of infestations on wild imported orchids made possible a continuation of the investigational work on the control of insects affecting these plants. Studies have also been made with native insects on proportional dosage schedules at temperature levels of 75°, 80°, 85°, 90°, and 95° F. Ten new treatment recommendations were prepared and put into use, and now practically all types of special permit material can be fumigated with methyl bromide.

A study was made of the effectiveness of various methods of vaporizing nicotine for greenhouse fumigation. In general, chemical analyses showed that nicotine concentrations were highest immediately after the start of fumigation, falling off rapidly in all methods tested. Little nicotine remained in the air after the first hour. The atomizer method gave a concentration near 40 percent of the dosage at high dosages, while the pressure can produced concentrations as high as 60 percent of the dosage immediately after application, and practically the same results were obtained when the fumigant was applied by means of the exhaust from a gasoline engine. With the smudge method 40 percent of the nicotine was present, and with nicotine papers 30 percent. Insecticidal action against various aphids was good at the higher dosages. Ranked in the order of their effectiveness, the pressure can appeared to be first, the exhaust method second, the atomizer and smudge methods about equal, and the nicotine papers last.

PHYSIOLOGY OF INSECTS

In a study of the oxygen consumption of various tissues from the sixth-instar southern armyworm, it was found that on the average the fat body consumed 3.89, the midgut tissue 7.70, the integument 1.08, and the gut contents 4.54 to 9.52 cubic millimeters of oxygen per milligram of tissue (dry weight) per hour. When lead arsenate, rotenone, and pyrethrum were added to the saline solution containing the midgut and fat-body tissues, oxygen consumption decreased, indicating that these insecticides could directly affect the metabolism of these particular tissues. Oxygen consumption of midgut and fat-body tissues was increased by the carbohydrates glucose, levulose, *d*-mannose, *l*-sorbose, maltose, and sucrose, but not by *d*-galactose, *l*-rhamnose, lactose, raffinose, or glycogen.

In a continuation of studies on the effect of blockage of the blood cells of the American cockroach with Chinese ink and of the nephrocytes with trypan blue, it was found that the resistance of the insect to sodium arsenite and nicotine was reduced. Resistance to pyrethrum was not affected by either treatment, and resistance to potassium fluoride was not influenced by blockage of the nephrocytes. These results may indicate that in some cases the blood cells have a protective function against certain insecticides or that the blood phagocytes are protective against blood bacteria. In the latter case interference of the insecticide with the phagocytic defense against bacteria should leave the bacteria free to help cause death of the insect. Evidence to support the second alternative has been obtained by histochemical methods.

APPLICATION OF INSECTICIDES

The method and apparatus for applying insecticides in an air-blended mixture from an autogiro were tested on other mixtures than lead arsenate and fish oil. Calcium arsenate, paris green, cryolite, and other insecticidal mixtures were distributed very satisfactorily by the machine. Approximately 600 acres of mountainous forest land were treated for the gypsy moth with air-blended lead arsenate and fish oil this season in a commercial application of the method.

INSECTICIDE INVESTIGATIONS

Research to develop new and more effective insecticides was actively prosecuted, and the results were made available to the public by means of 44 scientific publications, comprising 1 Circular, 7 articles in the Bureau's E series, and 36 articles in technical and trade journals. Six patents were issued to members of the Division, and the monthly Review of the United States Patents Relating to Pest Control was issued regularly and distributed to a large number of foreign and American entomologists.

INSECTICIDES OF VEGETABLE ORIGIN

The search for new insecticides among the products of growing plants was continued. Investigations of new means of utilizing nicotine, except for the study of nicotine bentonite, were transferred to the Eastern Regional Laboratory of the Bureau of Agricultural Chemistry and Engineering.

Emphasis was given to work on nornicotine. The levo form of this alkaloid was found to constitute 95 percent of the total alkaloids of a Maryland tobacco that had been cultivated in an effort to produce a mild low-nicotine type. The occurrence of nornicotine as the predominating alkaloid of tobacco appears to have been hitherto unrecognized. Nornicotine is known to possess insecticidal power, but heretofore has been obtainable only from certain Australian solanaceous plants. The recovery of a considerable quantity from the tobacco mentioned was undertaken with the object of making it available for tests against many kinds of insects, in the hope that for some of them it might be even more toxic than nicotine.

Pyrethrum flowers continue to be one of the most widely used insecticides, 15 to 20 million pounds being imported annually for the manu-

facture of household fly sprays, cattle sprays, and insecticidal dusts. During the year the study of the chemical structure of the active principles, pyrethrin I and pyrethrin II, was completed.

A new method for the determination of the pyrethrins, which is applicable to pyrethrum flowers, oleoresins, and pyrethrin concentrates, was developed. The procedure involves hydrogenation of the sample in an acetone-ethyl alcohol solution under pressure. The method is much shorter than any now in use and is believed to be more accurate. Research was begun on materials which may be added to the pyrethrins to enhance their action and thus conserve their use against the time when imports of pyrethrum flowers may be seriously curtailed or even cut off by shipping conditions. Sesame oil has been found by the Division of Insects Affecting Man and Animals to increase the kill of houseflies by a pyrethrum-kerosene spray, and the Division of Insecticide Investigations began an investigation of sesamin, the active constituent of sesame oil, as well as of other related compounds, such as asarinin, which occurs in the American prickly ash, pinoresinol from spruce gum, and eudesamin found in the kino gums of eucalyptus.

The use of rotenone-bearing plants, introduced into this country by the Department several years ago, continues to increase, the annual consumption amounting now to 6½ million pounds. All this material is at present imported, much from the Dutch East Indies and Singapore, and hence is liable to disturbance from unsettled world conditions. The plant known as devil's shoestrings (*Tephrosia virginiana* (L.) Pers.), in which rotenone was discovered by this Division several years ago, is being bred by the Department in an effort to bring its rotenone content up to a figure that will make it a commercially valuable source of this insecticide. During the year the total resins of this plant were investigated and the results will be of value when its commercial possibilities are established.

The investigation of the Chinese thunder-god vine (*Tripterygium wilfordii* Hook., f.) was continued. It was found that at least two alkaloids are present, which account for the insecticidal value of the plant. Both have been prepared in crystalline, but not entirely pure, form, and the determination of their chemical structure is under way.

SYNTHETICS

While the search for new organic insecticides embraced, as usual, the preparation of several hundred compounds and their preliminary testing by entomologists of the Bureau, emphasis was placed on the further development of four compounds which such preliminary tests had indicated were most worthy of development to the practical stage. These compounds are phthalonitrile, p-aminoazobenzene hydrochloride, p-aminoacetanilide, and diphenyl semicarbazide. They were prepared in considerable quantity, and are under small-scale plot or field tests against many kinds of insects.

Phenothiazine, a synthetic organic compound developed by this Division as a possible means of control for the codling moth larva, gained new importance this year by the discovery that when ground to an exceedingly fine particle size it is much more effective than when in the usual commercial powdered form.

FUMIGANTS

A new method of applying insecticides was developed, by which it is possible to disperse in air many nonvolatile compounds, not ordinarily considered as fumigants, so finely as to make them act like fumigants. Several means of producing these fine dispersions were developed, namely, (1) burning a mixture of the insecticide with a smoke-producing substance such as cornstalks, (2) spraying a solution of the insecticide onto a heated surface, and (3) suddenly releasing from a cylinder a solution of the insecticide in a volatile solvent such as dichlorodifluoromethane. Derris and pyrethrum extracts have been found to be much more effective when applied in these ways; ortho-dichlorobenzene, a cheap product now used against termites, becomes a promising fumigant; and numerous solid organic compounds are enabled to exercise their insecticidal power in a new and more efficient manner. The use of solutions of pyrethrum extract in highly volatile solvents appears to have a good chance for immediate adoption for the control of malaria and yellow fever mosquitoes on airplanes arriving in this country from foreign lands.

INORGANIC INSECTICIDES

An investigation of sodium arsenite as used for control of Mormon crickets was completed, which gives a clearer insight into the nature of this insecticide, correcting certain errors in work previously published by other investigators, and describing two new sodium arsenites not previously isolated.

ANALYTICAL WORK

The Division continued to serve the rest of the Bureau by testing the quality of the experimental materials under study. At those field stations at which chemists are permanently stationed, direct assistance in solving specific problems was given. At Beltsville, Md., nearly 900 samples of miscellaneous insecticides were analyzed for several of the other divisions. At Moorestown, N. J., assistance was given to the entomologists developing control measures for the Japanese beetle, involving analyses of about 900 samples of soils treated with lead arsenate, a study of wet versus dry application of this insecticide to soils, a study of attractants for the beetle, development of new means of soil fumigation against the larvae, and a study of the behavior of certain fumigation boxes when used with methyl bromide. At the Vincennes, Ind., and Yakima, Wash., laboratories the chemical phases of the control of codling moth larvae included systemization of spray-residue analyses, so that it is possible now to conduct the many thousands of analyses necessary to follow all spray programs under study there. At Manhattan, Kans., determinations were made of hydrocyanic acid concentrations during fumigation and of the quantity absorbed by fumigated products; many controlled fumigations were also run with methyl bromide to obtain samples for the study of its retention by fumigated products. At Whittier, Calif., assistance was rendered to the entomologists studying the resistance of the California red scale to fumigation with hydrocyanic acid; this work involved the conducting of fumigations under controlled conditions and led to the development of a new fumigating device, which includes a circulating blower to give uniform distribution of hydrocyanic acid under a citrus-fumigation tent.

TRANSIT INSPECTION

The inspection of shipments moving interstate via parcel post, express, freight, and truck was conducted during the year at 22 transportation centers, 8 of which were operated on a seasonal basis. Out of a total of 1,407,769 shipments examined, in addition to 2¼ million waybills, 2,839 were found moving in violation of 9 Federal domestic plant quarantines. One thousand six hundred and forty shipments of plants were also found to be moving in apparent violation of State pest-control or nursery-stock certification requirements and were reported to the States concerned.

The scope of protection to the Nation's agriculture by this work is indicated by the fact that shipments which might have carried pests, concerning which Federal quarantines have been established to help prevent their spread, were intercepted in transit to 48 States, the District of Columbia, and Canada.

Cooperation was received from affected States and from other agencies of the Bureau in the assignment of inspectors to assist in the work, principally during the heavy nursery-stock shipping season. Assistance from officials of the Post Office Department and other common carriers contributed greatly to the efficiency with which the work was accomplished.

Data pertaining to shipments intercepted at transit-inspection points are given in table 11.

TABLE 11.—*Number of shipments of nursery stock and other articles intercepted in violation of Federal domestic plant quarantines at transit-inspection points, fiscal year 1941*

Station	Shipments intercepted in apparent violation of quarantines relating to—									
	Black stem rust	Gypsy moth and brown-tail moth	Japanese beetle	Pink bollworm	Thurberia weevil	White-pine blister rust	Mexican fruitfly	Dutch elm disease	White-fringed beetle	Total
Atlanta	1	3	43	11		11	33		26	128
Birmingham			11				7		42	60
Boston		201	92							293
Buffalo	3	17	72			21	17			130
Chicago	3	17	131	3	1	6	120			281
Cincinnati	1	1	17	2		2	2			25
Dallas				23			115		4	142
Detroit		35	3				18			56
Houston				7			24			31
Jacksonville		4	80						1	85
Kansas City		4	25	1			30			60
Memphis		5	5	4		1	10		18	43
New York		324	379			9			5	717
Omaha		12	62				3		1	78
Philadelphia		13	124				4		1	142
Pittsburgh	2	6	265	1		7	19			300
St. Louis		1	15	1			42		1	60
St. Paul			14			5	9			28
Shreveport							1			1
Springfield, Mass		70	3							73
Texarkana							17			17
Washington, D. C		18	80	1			8			107
State of California		2	34	12		4		1	2	[1] 55
Total	10	733	1,455	66	1	66	479	1	101	[2] 2,912

[1] Intereeptions reported by eooperating State inspeetors at several inspection points.

[2] The total number of violations represents 2,839 shipments, 69 of whieh were in violation of 2 quarantines and 2 in violation of 3 quarantines.

TERMINAL INSPECTION OF MAIL SHIPMENTS

The State of Minnesota in March 1941 made arrangements through Federal channels to maintain terminal inspection at St. Paul of woody plants, perennial roots, small-fruit plants, herbaceous perennials, and cuttings, buds, grafts, and scions for or capable of propagation. Arrangements were also made by that State for the enforcement, under the provision of the amendment of June 4, 1936, to the Federal Terminal Inspection Act, of the Minnesota quarantines pertaining to the alfalfa weevil and certain diseases of raspberry plants.

Other States which have availed themselves of the provisions of this terminal-inspection procedure for the enforcement of their quarantine regulations are Arizona, Arkansas, California, Florida, Mississippi, Montana, and Oregon.

Arizona, California, Florida, Idaho, Louisiana, Minnesota, Mississippi, Montana, Oklahoma, Oregon, the District of Columbia, Hawaii, and Puerto Rico maintain terminal inspection of designated types of plants and plant products under the procedure which provides for the turning back or disinfection of shipments found to be infected.

CONVICTIONS AND PENALTIES IMPOSED FOR VIOLATIONS OF THE PLANT QUARANTINE ACT

The Bureau continues to receive the wholehearted cooperation of the general public in its administration of the plant quarantines of the Department. Such cooperation is evidenced by the fact that, aside from violations relating to Mexican plants and plant products along the southern border, for the first time since 1918, the first year that a record of them was made in the annual report, not a single conviction for violation of the Plant Quarantine Act was obtained.

Fines aggregating $301.60 were imposed by customs officials on the Mexican border against 283 persons caught attempting to smuggle in prohibited plants and plant products from Mexico. A total of $492.70 was assessed against 463 persons for similar offenses last year.

FOREIGN PLANT QUARANTINES

The Division of Foreign Plant Quarantines is engaged in the enforcement of quarantines and regulatory orders of the Department prohibiting or restricting the entry from foreign countries, or the movement from Puerto Rico and Hawaii to the mainland of the United States, of various plants and plant products, and restricting the movement of nursery stock into and out of the District of Columbia. In addition, this Division is responsible for the maintenance of a service to inspect and certify plants and plant products to meet the sanitary requirements of foreign countries and for the enforcement of the provisions of the Insect Pest Act of 1905.

Plant-quarantine inspectors and collaborators are stationed at the more important ports of entry and at certain interior ports where foreign mail is distributed. They work in close cooperation with employees of the Treasury and Post Office Departments.

MARITIME-PORT INSPECTION

SHIP INSPECTION

Ships from foreign countries and also those from Hawaii and Puerto Rico and the coastwise ships which pass through the Panama Canal are inspected promptly on arrival for the presence of prohibited and restricted plant material. This inspection involves the examination of ships' stores and quarters, passengers' and crews' baggage, and cargo.

The inspection at ports in California, Florida, and Hawaii and at certain ports in Puerto Rico has been performed by State and Territorial officials serving as collaborators of the Bureau.

A record by ports of the ship inspection appears in table 12.

CARGO INSPECTION

All importations of plants and plant products subject to plant-quarantine restrictions are inspected at the port of entry or at the port of first arrival. A summary of such importations grouped under 4 general subdivisions appears in table 13. The present disturbed world conditions have had their effect on the flow of plants and plant products into this country. As compared with importations in 1940, there have been large increases in some commodities as well as decreases in others. For example, there was an increase of nearly 1½ million containers of fruits and vegetables imported, or about 20 percent, over 1940, but there was also a decrease of over 3 million, about 6 percent, bunches of bananas imported. The number of containers of nursery stock and seeds imported in 1941 was less than half the number imported in 1940, but cotton, bagging, and cotton products showed an increase of over 290,000 bales, about 58 percent, over last year. The number of miscellaneous containers of the latter commodities was more than 12 times the number imported in 1940, but the material reported by pounds was nearly 9 million pounds less. The various cereals and fibers recorded in the fourth general subdivision of table 13 show marked increases in importations over 1940. The striking feature here is the increase from 2,008,960 bushels in 1940 to 205,274,709 bushels in 1941. This is largely due to the importation, and in some instances storage, under close supervision for transshipment to England, of Australian wheat, which is prohibited entry for consumption into the United States on account of flag smut.

Special efforts are made, in cooperation with defense agencies and interests, to avoid any delays in the inspection and release of these importations generally, in order that the material may be moved even more promptly than in the past to clear the docks and piers for other cargo.

In addition to the commodities listed in table 13, 527 lots of plant material were entered at Canadian border ports where no plant-quarantine inspectors are stationed, through the cooperation of the customs officers and the Division of Foreign Pests Suppression of the Canadian Department of Agriculture. These importations consisted of 2 small quantities of fruits and vegetables; 2 dozen broomcorn brooms; 4,785 bales of bagging, cotton, and cotton waste; 30 pounds of corn on the cob and 694,342 bushels of shelled corn; and 265 containers of, and 2,526 individual, plants and bulbs.

TABLE 12.—*Number of ships inspected, fiscal year 1941*

Port	From foreign ports												From Hawaii						From Puerto Rico						From United States ports via Panama Canal		
	Direct			Via United States ports			Via Hawaii			Via Puerto Rico			Direct			Via United States ports			Direct			Via United States ports					
	Arrived	Inspected	With prohibited material	Arrived	Inspected	With prohibited material	Arrived	Inspected	With prohibited material	Arrived	Inspected	With prohibited material	Arrived	Inspected	With prohibited material	Arrived	Inspected	With prohibited material	Arrived	Inspected	With prohibited material	Arrived	Inspected	With prohibited material	Arrived	Inspected	With prohibited material
Baltimore	846	845	380	773	550	294										72	7	2	22	22	5	46	25	1	211	29	1
Blaine [1]	313	28	8	301	11	6																					
Boston [2]	1,005	999	336	346	345	67	45	45	11	1	1		5	5		15	15		21	21	2				159	159	
Brownsville				6	6	1																					
Buffalo	2	2	1																								
Charleston [3]	282	255	84	59	57	11				3	3	2							5	4	1	34	33		10	10	
Chicago [4]	2	2		6	3												2										
Corpus Christi [5]	7	7	2	7	7	1																			2	2	
Detroit	1,317	5	1																								
Eureka [6]	2	2	1	5	5								1	1		4	4										
Galveston	292	291	104	251	239	57	1	1					1	1	1	1	1		8	8	2	3	3		2	2	
Gulfport [7]	8	8	7	8	3	3																2					
Honolulu [6]	372	372	71	3	3																				165	165	
Houston	222	222	85	259	223	47										4	4		2	2		5	5		21	21	
Jacksonville [6]	362	362	39	32	25	2				1	1								32	32		4	1		2	2	
Key West [6]	177	158	52																								
Miami [6]	1,444	1,444	354	7	7	1													3	3							
Mobile	364	364	157	180	157	53	1	1		3	3	2				11	11		8	8	2	35	32	1	10	10	2
New Orleans	1,162	1,162	476	361	348	112	4	4	3				3	3	1	19	18	2	13	13	3	29	29	1	32	32	1
Newport News	90	90	48	306	263	83																4	4		4	4	
New York	3,547	3,457	1,719	829	619	217				61	61	55	22	22	3	58	44	4	146	145	38	20	11	2	254	207	4
Norfolk	521	521	221	593	464	180				1	1		2	2	2	4	4		13	13		19	19		35	18	
Pensacola [6]	33	33	19	32	32	8																					
Philadelphia	1,017	1,017	349	730	636	348	14	14	9	2	2		1	1		56	38	4	61	61	17	15	9	2	279	75	
Port Arthur	123	123	78	244	213	39													14	14	2	3	3		4	4	
Portland, Oreg	95	95	46	147	141	30	5	5	5				5	5		13	8								336	20	
Port San Luis [6]	39	39	36										10	10	1												
Puerto Rico (all ports)	914	914	191																						20	19	6
San Diego [6]	1,106	1,105	29	6	6		1	1					157	157	24										40	40	

San Francisco [6]	321	319	212	490	488	131	123	122	95				263	263	63	73	54	18							538	537	16
San Pedro [6]	1,216	1,216	613	297	296	90	100	100	61				195	195	50	76	76	6							687	686	79
Savannah [8]	109	109	45	111	110	33							1	1	1	2	2		4	4	1	15	15	1	8	8	1
Seattle	1,250	1,240	185	248	215	60	1	1					17	17	1				1	1	1				271		
Tampa [6]	278	278	82	228	167	45													31	31	3	3	1				
Ventura [6]	1	1		3	3								11	11											1	1	
West Palm Beach [6]	165	165	16	4	4																						
Total	19,004	17,250	6,047	6,872	5,646	1,919	295	294	184	72	72	59	694	694	147	408	288	36	384	382	77	237	190	8	3,091	2,051	110

[1] Includes ships arriving at Bellingham and Anacortes.
[2] Includes Providence, R. I.
[3] Includes Georgetown, S. C., and Wilmington and Morehead City, N. C.
[4] Does not include ships in lake trade only arriving direct from Canada, as these are not usually inspected on arrival, although 21 such ships were inspected to determine by the process of sampling the character of the plant material carried in their stores.
[5] Inspector stationed at this port on Mar. 1, 1941.
[6] Collaborators stationed at these ports.
[7] Work handled by inspector at Mobile.
[8] Includes Brunswick.

NOTE.—Foreign-ship arrivals do not in all cases agree with customs figures. Ships which put in for bunkers may not be counted by customs. Ships entered at certain small subports and counted by customs are not included in this report.

TABLE 13.—*Summary of importations of plants and plant products inspected, fiscal year 1941*

Port	Fruits and vegetables		Nursery stock and seeds		Bagging, cotton, cotton products		Bagasse, broomcorn, corn, rice, fiber, etc.	
	Containers	Additional quantities	Containers	Additional quantities	Bales	Additional quantities	Bushels	Additional quantities
	Number		*Number*		*Number*		*Number*	
Baltimore	31	4,730,361 bunches, 1,962 pounds.	164	27,540 pounds	300	649,407 containers	2,929	600 containers.
Baltimore, for export	600		4		11,681		816,861	
Blaine		2,995 bunches	9,782	39 units, 707 pounds				
Boston	1,074	2,633,514 bunches	626	26 units, 329 pounds	106,749	489,790 containers	1,980	
Boston, for export					279,181	157 containers		
Brownsville	15,851	38,823 bunches, 50 units, 13,351 pounds.		6,521 units, 6 pounds		733,984 pounds		2,962 pounds.
Buffalo			7	6,944 units, 300 pounds	977			
Buffalo, for export					1			
Calexico	6,316	152,830 pounds			65,719	1,024 containers, 13,644,384 pounds.		
Charleston		2,562,503 bunches						
Del Rio	37						4	
Detroit	94		14	12,841 units	3,737		3	
Douglas	520	755 pounds					3	
Eagle Pass	5,465	2,297 bunches, 28,748 pounds.					5	913 dozen.
El Paso	87,435	907,808 bunches, 10 pounds.		42 units		1,456,814 pounds		
El Paso, for export	14		2			16,135 pounds	36	
Galveston	9,851	2,853,514 bunches			890			
Hidalgo	2,128							81 dozen.
Hoboken			1,751	30 pounds				
Honolulu [1]	2,626		388	258 pounds	40			361 containers.
Honolulu, for export	124							8 containers.
Houston					787			
Jacksonville [1]	862	2,991,142 bunches, 80 pounds.					59,600	
Key West [1]	5,126	21,994 bunches						
Laredo	163,100	1,508,030 bunches, 8,680,987 pounds.		17,380 units, 1 pound			22	4 dozen.
Mercedes		6,700 pounds						
Miami [1]	738,072	348,557 bunches, 12,996 pounds.	41	11,907 units, 376 pounds			1	
Miami, for export			12					1 container.
Mobile		2,668,124 bunches						
New Orleans	228,664	10,243,339 bunches		54 pounds	1,405			2,600 containers.
New Orleans, for export	1,740		13		13			

New York	3,501,357	11,087,593 bunches, 46 pounds.	19,854	6,188 pounds	160,921	602,273 containers	58,727	2,929 containers.
New York, for export	125,056	372 bunches	353		99,122		220,260	2,838 containers.
Niagara Falls [2]	1,302		33	66,271 units, 617 pounds	1,497	3 containers		
Niagara Falls, for export				60 units	3			
Nogales	3,346,072	6,184 units, 191 pounds		591 units, 1 pound	73		3,519	740 containers, 4 dozen.
Nogales, for export	2,054	2 bunches			3			
Norfolk		253,977 bunches			4,101			
Philadelphia		3,886,053 bunches	1,420		14,866	141,458 containers	24,254	95 units.
Philadelphia, for export							201,358,782	
Port Huron [3]				405 units	3,204			
Portland	120	381,711 bunches	40		650	46,193 containers		
Presidio	4						45	
Providence [4]					12,686			
Puerto Rico (all ports)	22,179	579 bunches, 19,036 pounds.	7,244	3,546 units, 951 pounds		1 container	506,839	
Puerto Rico, for export				100 units			3,428	17,900 pounds.
St. Albans	4,326		5	60 pounds	1,922	6 containers	1,208,842	
St. Albans, for export				1 unit	302	3 containers		
St. Paul				20 pounds	17			
San Diego [1]				44 units				
San Francisco [1]	15,055	1,149,030 bunches	4,591	296 units, 2,861 pounds	5,534	32,727 containers	363,811	3 containers.
San Francisco, for export	156		3	5,335 pounds	420	55 containers		107 containers.
San Pedro [1]	7,471	2,099,233 bunches	1,851	10,812 pounds	8,919	35,810 containers	476,000	660 containers.
San Pedro, for export	10			1,756 pounds	525			26 units.
San Ysidro	6,469		2	109 units				
San Ysidro, for export	6,300							
Sault Ste. Marie [3]		1,753 bunches						
Seattle	111,899	566,364 bunches, 583 pounds.	61,986	7,085 units, 13,240 pounds.	3,024	39,156 containers	149,123	
Seattle, for export						64 containers		
Tampa [1]	106,616	701,758 bunches					19,635	
Washington			47	470 units, 3,363 pounds		2 containers		
Total	8,526,176	51,641,426 bunches, 8,918,275 pounds, 6,234 units.	110,233	74,805 pounds, 134,678 units.	789,269	2,038,129 containers, 15,851,317 pounds.	205,274,709	10,847 containers, 20,862 pounds, 1,002 dozen, 121 units.

[1] Collaborators stationed at these ports.
[2] Work handled by inspector at Buffalo.
[3] Handled through customs.
[4] Work handled by inspector at Boston.

At the Mexican border ports there were several thousand importations of fruits and vegetables in such small quantities that no entries were required by customs and no plant-quarantine record of them was kept; hence they do not appear in the table. All these small importations were carefully inspected before being released, and their handling represented a great deal of work, especially at the larger ports.

Many of the ports have devoted considerable time to the inspection of packing materials used in connection with commodities not subject to plant-quarantine restriction. When prohibited packing material is discovered, it must be treated or removed and destroyed under the supervision of a plant-quarantine inspector. This activity brought to light a return, owing to wartime conditions in England, to the use of elm wood with bark adhering in the construction of crates used to ship earthenware from England to this country. At the port of New York 5,160 crates were examined, 232 of which were found to contain elm along with other woods, and in 12 instances it was determined that the elm was infected with *Ceratostomella ulmi*, the cause of the Dutch elm disease. In 4 of these instances live scolytids, the vectors of the disease, were present.

DISINFECTION

Disinfection is required of certain commodities as a condition of entry and of other commodities when inspection reveals the presence of injurious insects or plant diseases. The following plant material was treated under the supervision of inspectors and collaborators of this Bureau:

Bagasse	2,545 bales.
Bagging	252 bales.
Brooms—sorghum	12 crates.
Broomcorn	1 case.
Bulbs	359 containers, 21,583 units.[1]
Chestnuts	22,201 containers.
Cipollini	14,650 cases.
Cotton	185,038 bales.
Cotton linters	227,184 bales.
Cotton samples	14,159 containers.
Cotton waste	64,369 bales.
Kudzu seed	9 containers.
Lima beans	22 hampers.
Miscellaneous plants	2,357 containers, 1,324,073 units.[1]
Narcissus	34 containers, 7,109 units.[1]
Orchids	178 containers, 3,252 units.[1]
Pigeonpeas	4,191 hampers.
Rice fiber	313 bales.
String beans	86 hampers.
Tree seed	249 containers, 1,127 pounds.

[1] Refers to plants, cuttings, bulbs, roots, or other propagating units concerned.

AIRPLANE INSPECTION

The number of airplanes from foreign countries has continued to increase, and the possibility of introducing plant pests through this rapid means of transportation increases accordingly. During the year 6,946 airplanes from foreign countries were inspected, an increase of 1,667, or 32 percent, over 1940. These inspections were made at the following 25 ports of entry: Douglas, Nogales, and Sonoyta, Ariz.; Calexico, Los Angeles, San Diego, San Francisco, and San Pedro, Calif.; Jacksonville, Key West, Miami, Tampa, and West Palm Beach, Fla.; Honolulu, T. H.; New Orleans, La.; Baltimore, Md.; New York, N. Y.; San Juan, P. R.; Brownsville, Eagle Pass, El Paso, and Laredo, Tex.; Newport News and Norfolk, Va.; and Seattle, Wash.

Seven hundred and fifty-five of the airplanes inspected were found to carry prohibited plant material, much of which came from places where it is known to be the host of injurious plant pests.

Eight hundred and thirty interceptions of insects and plant diseases were made in connection with the airplane inspection. These represented specimens taken from plant material carried in baggage, cargo, mail, and stores, and also insects which were being carried as stowaways on the planes. The insects intercepted were not only possible plant pests, but many of them represented different species of mosquitoes and other insects that might have decided importance from the human-health standpoint. Most of the plant diseases intercepted and completely determined were species that are well established here, but one leaf spot of gardenia and four orchid diseases were not known to be established in the United States. While most of the intercepted insects represented forms which may be considered as having little economic importance, there were many which could be identified as to genus only, hence it is impossible to estimate their importance from a plant-pest standpoint. Interceptions of such well-known pests as the Mediterranean fruitfly (*Ceratitis capitata* Wied.), other fruitflies belonging to the genus *Anastrepha*, species of Aleyrodidae, the pink bollworm, and several species of coccids were included.

FOREIGN PARCEL-POST INSPECTION

Inspection of foreign parcel-post packages is carried on through the cooperation of customs and post-office officials. Under an arrangement which has been in effect many years, foreign mail packages found to contain plants or plant products are referred to inspectors of this Bureau for examination. Such packages arriving at ports of entry where no plant-quarantine inspectors are stationed are forwarded to the nearest port where inspection can be made.

424011—42——8

A record by port of the number and disposition of foreign parcel-post packages inspected appears in table 14.

TABLE 14.—*Number of foreign parcel-post packages inspected, fiscal year 1941*

Port	Inspected	Refused entry (entire or in part)	Diverted for disposition	Released under permit
Atlanta [1]	6		48	
Baltimore	606	10	72	22
Boston	2,561	46	739	26
Brownsville	1,290	2		9
Buffalo	1,610	11	117	12
Chicago	1,707	25	20	23
Detroit	1,291	22	26	30
Eagle Pass	360			
El Paso	450	25	20	11
Hoboken	1,856	31	1	1,555
Honolulu [1]	2,663	250		262
Houston	207	1	94	0
Jacksonville [1]	72	8	7	8
Laredo	2,375	37	23	35
Los Angeles [1]	3,365	36	19	17
Miami [1]	61	13	19	4
New Orleans	224	13	100	9
New York	58,517	80	8,153	117
Nogales	360	4	6	3
Philadelphia	2,152	24	208	21
Portland	351	8		10
Puerto Rico (all ports)	22	6		14
St. Albans	385	2	16	4
St. Paul	11,072	12	41	61
San Diego [1]	18			0
San Francisco [1]	5,051	39		533
Seattle	1,462	44	5	358
Tampa [1]	15	2	2	
Washington, D. C	3,945	15	3,147	222
Total	104,054	766	12,883	3,366

[1] Collaborators are stationed at these ports.

MEXICAN BORDER SERVICE

A total of 43,723 freight cars from Mexico were inspected during the year, which represents an increase of 7,248, or 20 percent, over the number inspected during 1940. Three hundred and seventy-nine more cars were contaminated with cottonseed than in 1940, and 7,176 more cars entered than in the previous year. The cars contaminated with cottonseed were required to be cleaned before entry was permitted. The usual fee of $4 was charged for each car fumigated, and all fees collected were turned into the Treasury as miscellaneous receipts.

A summary of the railway-car inspection and fumigation is shown in table 15.

In addition to the freight cars listed in table 15, 14,429 pullman and passenger coaches entered and were inspected at the following ports: Brownsville 1, El Paso 1,271, Laredo 2,169, Naco 1, Nogales 405, Roma 10,582. A total of 3,180,029 other vehicles and 698,105 pieces of baggage were examined in cooperation with the customs officials.

TABLE 15.—*Inspection and fumigation of railway cars crossing the border from Mexico, fiscal year 1941*

Port	Cars inspected	Cars with cottonseed	Cars entered	Cars fumigated	Fees collected
	Number	*Number*	*Number*	*Number*	*Dollars*
Brownsville	1,005	58	1,003	73	292
Douglas	2,323	17	2,323	21	84
Eagle Pass	2,548	174	2,548	519	2,000
El Paso	11,435	235	11,435	884	3,200
Laredo	14,898	1,296	13,539	1,886	7,596
Naco	967	14	967	2	8
Nogales	9,964	461	9,934	659	2,600
Presidio	583	12	583	11	40
Total	43,723	2,267	42,332	4,055	[1] 15,820

[1] The apparent discrepancy in fees collected and the number of cars fumigated may be explained by the fact that it is customary for the railroads to purchase fumigation coupons in advance.

INSPECTION IN PUERTO RICO AND HAWAII

The outstanding feature in the enforcement of Quarantine 58, governing the movement of fresh fruits and vegetables from Puerto Rico to the mainland, was the revision of this quarantine, effective January 22, 1941, to permit movement without certification of a considerable number of products, including most of the fruits and vegetables grown for commercial shipment, when inspections made on the island disclose no pest conditions which would require a return to certification procedure. Owing to this revision, certification activities have greatly decreased, although 1,264 shipments, consisting of 723 bunches of bananas, 63,307 crates of pineapples, and 5,592,528 pounds of other approved fruits and vegetables, were certified throughout the year.

With the cooperation of post-office officials, parcel-post packages destined for points on the mainland were inspected at the four main post offices on the island. This arrangement makes it possible to intercept much prohibited plant material before it leaves the island and also reduces considerably the number of Puerto Rican mail packages requiring inspection on arrival in New York. A total of 4,398 parcel-post packages were examined, and the 48 found to contain prohibited plant material, which were returned to the senders, represent a marked decrease from last year.

The enforcement of foreign plant quarantines and regulations as they affect the entry of foreign plants and plant products into the island is under the general supervision of the inspector in charge of the enforcement of the provisions of Quarantine 58, who is assisted in this phase of the work by the insular inspectors acting as collaborators. Airplane arrivals increased to 876 as compared with 616 of the previous year. All planes requiring inspection have been landing in San Juan and vicinity and have been examined by the inspectors of the San Juan office.

In Hawaii the enforcement of foreign plant quarantines is handled wholly by Territorial inspectors serving as collaborators. The in-

spectors of this Bureau stationed in the Hawaiian Islands are engaged in the enforcement of Quarantine 13, which governs the movement of fresh fruits and vegetables to the mainland.

During the year 3,175 shipments, consisting of 104,277 bunches of bananas, 76,687 crates of pineapples, 108,322 coconuts, and 2,196,763 pounds of other approved fruits and vegetables, were inspected and certified for movement to the mainland. Of these, 131 pounds of avocados, 75 pounds of bananas (cooking), and 273,010 pounds of papayas were given approved sterilization treatment; 18,710 pounds of tomatoes were fumigated with methyl bromide, and 200 pounds of papaya pulp were given low-temperature treatment in Hawaii under close supervision.

Inspections were made in the fields, in packing houses, and on the docks. The inspection of parcel-post packages destined for points on the mainland requires considerable time and effort. During the year 629,815 such packages were handled; of these 190,176 were opened and inspected, and 163 were found to contain prohibited material. There was an increase of 231,880, or 50 percent, in the number of parcel-post packages handled over the previous year.

Since the inauguration of trans-Pacific air service it has been the practice not only to inspect the planes when they arrive from the Orient but also to inspect all planes, baggage, and express before the planes leave Honolulu for California. This procedure serves as an added precaution against the carrying of plant pests from Hawaii to the mainland and permits the prompt release of baggage and express upon arrival at the mainland. Under this arrangement, 86 airplanes, 4,013 pieces of baggage, and 4,702 air-express packages were inspected as compared with 58 airplanes, 2,248 pieces of baggage, and 2,995 express packages inspected in 1940. Inspections of airplanes arriving in Hawaii from foreign countries are included under the heading Airplane Inspection.

Other activities in Hawaii consisted in the inspection and sealing of 4,857 pieces of baggage and the inspection of 499 pieces of express leaving Hawaii by boat.

INSPECTION OF SPECIAL-PERMIT AND DEPARTMENTAL PLANT MATERIAL

Importations of most kinds of propagating plant material are inspected at ports of entry designated for that purpose. Most of such importations were formerly inspected and treated at the inspection house in Washington, D. C., but, effective July 1, 1940, this work was transferred to the newly erected and especially designed plant-inspection quarters in Hoboken, N. J. The work performed at Hoboken is recorded in tables 13, 14, and 18, and, while that city is in the confines of the Port of New York, this work is separate from that listed in these tables for New York. With the removal of the special-permit inspection work to Hoboken, suitable quarters were provided in Washington for the inspection and treatment, if necessary, of imported Departmental plant material and for housing the other inspectional activities remaining in Washington, which has the same status as other ports of entry listed in tables 13, 14, 17, 18, and 19. Recognition should be given to the fact that the greater part of the importations handled in Hoboken represented special-permit material and, as such, received very close inspection and frequently some sort of treatment as a condition of entry. The same applies to foreign

importations by the United States Department of Agriculture handled in Washington.

The enforcement of the regulations governing the movement of plant material into and out of the District of Columbia required the inspection of 535 shipments of incoming domestic material (consisting of 77,662 plants, cuttings, bulbs, etc., and 1,046 lots of seeds) and 1,858 shipments of outgoing domestic material (consisting of 163,183 plants, cuttings, bulbs, etc., and 14,972 lots of seeds). For the elimination of pests in these shipments 14,234 plants, 2,206 lots of seeds, and 131 parcels containing plant material not for propagation were given some form of treatment. In addition to the material listed 15,482 containers of plant material were examined at the post office, express office, and freight stations. Sixty-four truckloads of plants containing 222,859 plants consigned to retail merchants in the District of Columbia were checked on arrival for proper certification.

INSPECTION OF PLANT-INTRODUCTION AND PROPAGATING GARDENS

Plant material which is being propagated at plant-introduction and propagating gardens maintained by the Bureau of Plant Industry is inspected at regular intervals for the presence of plant pests. Plant material distributed from the plant-introduction gardens at Coconut Grove, Fla., and the propagating garden at Mandan, N. Dak., was inspected by State officials cooperating with this Bureau. The inspections at the plant-introduction garden at Chico, Calif., were handled jointly by an inspector of this Bureau and an entomologist from the California State Department of Agriculture. Material distributed from the District of Columbia, Maryland, and Savannah, Ga., was examined by inspectors of the Bureau. A summary of these inspections appears in table 16.

TABLE 16.—*Number of plants, bud sticks, cuttings, tubers, roots, and shipments of seeds examined for distribution from plant-introduction and propagating gardens, fiscal year 1941*

Garden	Plants	Shipments of seeds	Bud sticks and cuttings	Roots and tubers
Bell Station, Glenn Dale, Md	89,011	51	973	306
Chico, Calif	4,997	104	674	300
Coconut Grove, Fla	12,005	94	959	27
Savannah, Ga	4,661	2	157	29
Mandan, N. Dak	270,000			
Beltsville, Md	14,607			
District of Columbia	10,435	11,424	2,102	7,937
Total	405,716	11,675	4,865	8,599

INTERCEPTIONS OF PROHIBITED AND RESTRICTED PLANTS AND PLANT PRODUCTS

The inspection of ships, airplanes, vehicles, cargo, baggage, ship's stores and quarters, and foreign-mail packages at the various maritime and border ports of entry resulted in the interception of large quantities of prohibited and restricted plant material. Much of this material was infested with insects or infected with plant diseases of considerable economic importance. The interceptions made at bridges and crossings at the Mexican and Canadian border ports have been considered as having been taken from baggage. A record

of the number of interceptions of prohibited and restricted plant material appears in table 17.

TABLE 17.—*Number of interceptions of prohibited and restricted plants and plant products, fiscal year 1941*

Port	In baggage		In cargo		In mail		In quarters		In stores		Total	
	Prohibited	Restricted	Prohibited	Restricted	Prohibited	Restricted	Prohibited	Restricted	Prohibited	Restricted	Prohibited	Restricted
Baltimore	59	4	35	14	7	4	163	2	199		463	24
Blaine [1]	736	484									736	484
Boston	24	18	4	11	2	44	22	2	332	166	384	241
Brownsville	2,862	393	70	2			798	40	225		3,955	435
Buffalo [2]	2	422	1	1	5	6					8	429
Calexico	3,168	101									3,168	101
Charleston [3]	8	9		2			61		14		83	11
Chicago			23	1	18	4					41	5
Del Rio	623	180									623	180
Detroit [4]	11	555	4		19	6					34	561
Douglas	598	163		2			3	9			601	174
Eagle Pass	1,060	151	1								1,061	151
El Paso	7,019	968	118	214	16	10	385	10	15	5	7,553	1,207
Galveston	3						157	2	48		208	2
Gulfport [5]							1				1	
Hidalgo	2,259	291									2,259	291
Honolulu [6]	426	130	39	294	252	157			14	1	731	582
Houston	3						159		20	1	182	1
Jacksonville [6]	7				8		8	4	19	1	42	5
Key West [6]	87	149					1		8		96	149
Laredo	11,650	1,037			26	1					11,676	1,038
Los Angeles [6]	3	2		1	35						38	3
Mercedes	80	24									80	24
Miami [6]	1,147	1,552	45	9	10	3	229	515	126	15	1,557	2,094
Mobile	10	2	1				344	27	97	2	452	31
Naco	113	21									113	21
New Orleans	292	59	7	5	13		782	60	208	5	1,302	129
Newport News	1						34	1	8	1	43	2
New York	942	119	416	16	79	20	221	26	127	1	1,785	182
Nogales	2,416	567			1	3					2,417	570
Norfolk	1	3					124	5	44		169	8
Pensacola [6]	1						22		13		36	
Philadelphia	8	5	18	3	21	3	83	21	130	30	260	62
Port Arthur			2				224		39		265	
Portland, Oreg	24		16	1	8		36		27		111	1
Port San Luis [6]									1		1	
Presidio	146	22									146	22
Puerto Rico (all ports)	57	45			5	1	2	3	4		68	49
Roma	73	16					23				96	16
St. Albans		1				3						4
St. Paul			1		14	2					15	2
San Diego [6]	6	4	2				27	3	82	7	117	14
San Francisco [6]	376	1	40		23	16	102		115		656	17
San Pedro [6]	607	100	19				27	1	192	4	845	105
San Ysidro	11,696	1,564									11,696	1,564
Savannah [7]	2						116	2	20	1	138	3
Seattle	529	20	28	2	10	7	62		30		659	29
Tampa [6]	25	22	1		1		8	6	14	1	49	29
Washington, D. C					5	13					5	13
West Palm Beach [6]	13						9		2	11	24	11
Total	49,173	9,204	891	578	578	303	4,233	739	2,173	252	57,048	11,076

[1] Includes intereeptions made at Anaeortes.
[2] Includes intereeptions made at Niagara Falls.
[3] Includes intereeptions made at Georgetown, S. C., and Wilmington and Morehead City, N. C.
[4] Includes intereeptions made at Port Huron.
[5] Work handled by inspectors stationed at Mobile, Ala.
[6] Collaborators stationed at these ports.
[7] Includes interceptions made at Brunswiek.

NOTE.—In addition to the number of interceptions of prohibited and restrieted plants and plant produets shown in the table, there were 251 intereeptions of prohibited and 37 of restricted plant material in baggage by eustoms at Mexiean border ports, and 21 intereeptions of prohibited and 1,330 interceptions of restrieted plant material at Canadian border ports where no plant-quarantine inspectors are stationed.

PESTS INTERCEPTED

The inspectors and collaborators of the Bureau collected from foreign plants and plant products, and from such products received on

the mainland from Hawaii and Puerto Rico, insects belonging to 1,174 recognized species and others distributed among 776 genera and families, as well as fungi, bacteria, and nematodes belonging to 284 recognized species and fungi, bacteria, viruses, and other pathogens that could be referred to family, genus, or other group only. Many of these interceptions were of economic importance or of scientific interest, or both, including a number of apparently undescribed species.

A total of 75,367 interceptions of insects and plant diseases were made during the year. A summary of the interceptions appears in table 18.

TABLE 18.—*Number of interceptions of insects and plant diseases made during the fiscal year 1941*

Port	Consumption		Not offered for entry		Propagation		Total	
	Insects	Diseases	Insects	Diseases	Insects	Diseases	Insects	Diseases
Baltimore	25	6	69	54	1	1	95	61
Blaine	7	8	5	1	199	94	211	103
Boston	187	85	286	222	20	4	493	311
Brownsville	4,652	3,785	145	8	48	16	4,845	3,809
Buffalo	17	21	0	1	9	7	26	29
Calexico	2,114	49	0	0	0	0	2,114	49
Charleston	27	0	3	1	0	0	30	1
Chicago	20	9	0	0	0	0	20	9
Corpus Christi [1]	0	0	2	0	0	0	2	0
Del Rio	138	0	0	0	0	0	138	0
Detroit	0	1	0	0	4	0	4	1
Douglas	593	289	0	0	0	0	593	289
Eagle Pass	1,426	491	0	0	0	0	1,426	491
El Paso	12,540	2,346	14	2	1	1	12,555	2,349
Gainesville [2]	0	0	0	0	1	1	1	1
Galveston	25	85	57	223	0	0	82	308
Hidalgo	611	95	0	0	1	0	612	95
Hoboken	7	0	0	0	2,047	812	2,054	812
Honolulu [2]	48	0	54	0	369	0	471	0
Houston	0	0	18	22	0	0	18	22
Jacksonville [2]	16	0	12	8	0	1	28	9
Key West [2]	6	2	3	1	1	0	10	3
Laredo	3,604	405	2	0	234	53	3,840	458
Los Angeles [2]	2	0	0	0	1	0	3	0
Mereedes	57	5	0	0	0	0	57	5
Miami [2]	409	58	169	30	58	5	636	93
Mobile [3]	16	0	54	19	2	0	72	19
Naco	145	0	0	0	0	0	145	0
New Orleans	340	111	101	105	17	5	458	221
Newport News	1	0	4	0	0	0	5	0
New York	2,378	6,877	350	263	178	89	2,906	7,229
Nogales	11,921	6,406	5	0	39	1	11,965	6,407
Norfolk	35	0	51	22	14	0	100	22
Philadelphia	47	107	108	826	8	10	163	943
Port Arthur	1	0	18	3	0	0	19	3
Portland, Oreg	5	11	9	37	2	4	16	52
Presidio	15	0	0	0	7	0	22	0
Roma	31	9	2	0	10	6	43	15
St. Albans	11	0	0	0	0	0	11	0
St. Paul	11	3	0	0	5	0	16	3
San Diego [2]	7	1	6	0	0	0	13	1
San Francisco [2]	242	265	35	44	564	496	841	805
San Juan	22	6	6	1	63	38	91	45
San Pedro [2]	763	9	81	32	27	0	871	41
San Ysidro	329	2	3	1	5	0	337	3
Savannah	0	1	48	6	0	0	48	7
Seattle	142	488	105	180	252	161	499	829
Tampa [2]	21	9	16	3	2	3	39	15
Washington, D. C	0	0	0	0	265	90	265	90
Total	43,014	22,045	1,841	2,115	4,454	1,898	49,309	26,058

[1] Reopened Mareh 1, 1941.
[2] Collaborators stationed at these ports.
[3] Ineludes intereeptions made at Gulfport, Miss.

NOTE.—Inspectors stationed at Puerto Rico made 28 insect and 3 disease intereeptions during their field and packing-house inspection of fruits and vegetables for shipment to the mainland.

CERTIFICATION FOR EXPORT

During the year 4,378 certificates covering 1,209,654 containers of plants and plant products were issued to meet the sanitary requirements of foreign countries.

Export certificates were issued at 32 ports covering 70 different commodities which were exported to 71 foreign countries. Some of the more important commodities certified were the following: Apples, 164 shipments in 69,041 containers; grapes, 131 shipments in 59,726 containers; onions, 179 shipments in 68,746 containers; pears, 152 shipments in 102,597 containers; potatoes, 1,107 shipments in 428,653 containers; and tobacco, 178 shipments in 14,111 containers.

Many of the shipments of apples and pears were certified under the cooperative arrangement with the Agricultural Marketing Service of the Department, whereby licensed inspectors of that Service located at shipping points make inspections and issue reports which are accepted by the plant-quarantine inspectors at the ports of export as a basis for issuing the required export certificates.

Toward the close of the year arrangements were made to assist the armed forces in meeting the sanitary requirements of the countries concerned in connection with the movement of supplies to leased defense bases outside the limits of the United States.

A brief summary of the export-certification work appears in table 19.

TABLE 19.—*Certification for exportation, by ports, fiscal year 1941*

Port	Certificates issued	Total containers certified	Commodities certified	Foreign countries
	Number	*Number*	*Number*	*Number*
Baltimore	39	6,154	6	8
Boston	3	4	1	2
Brownsville	40	23,265	1	1
Buffalo	6	2,275	3	2
Calexico	99	32,485	6	1
Canal Zone	2	2	1	2
Chicago	5	36	2	3
Detroit	100	22,848	3	3
Douglas	2	2	2	1
El Paso	62	701	10	1
Galveston	43	16,194	4	2
Hidalgo	20	663	4	1
Houston	24	32,189	5	5
Jacksonville	3	4	1	3
Laredo	10	64	4	1
Los Angeles	50	2,922	10	2
Miami	4	2,640	1	1
New Orleans	93	37,995	7	6
Newport News	167	14,012	1	2
New York	2,786	760,439	39	46
Nogales	46	128	4	1
Norfolk	5	223	2	3
Philadelphia	17	34	5	4
Portland	89	47,774	10	8
St. Albans	1	5	1	1
San Francisco	170	104,047	20	12
San Juan	1	1	1	1
San Pedro	38	19,851	7	5
Savannah	1	1	1	1
Seattle	92	81,181	13	6
Tampa	18	883	3	2
Washington, D. C	342	632	9	60
Total	4,378	1,209,654		

U. S. GOVERNMENT PRINTING OFFICE: 1942